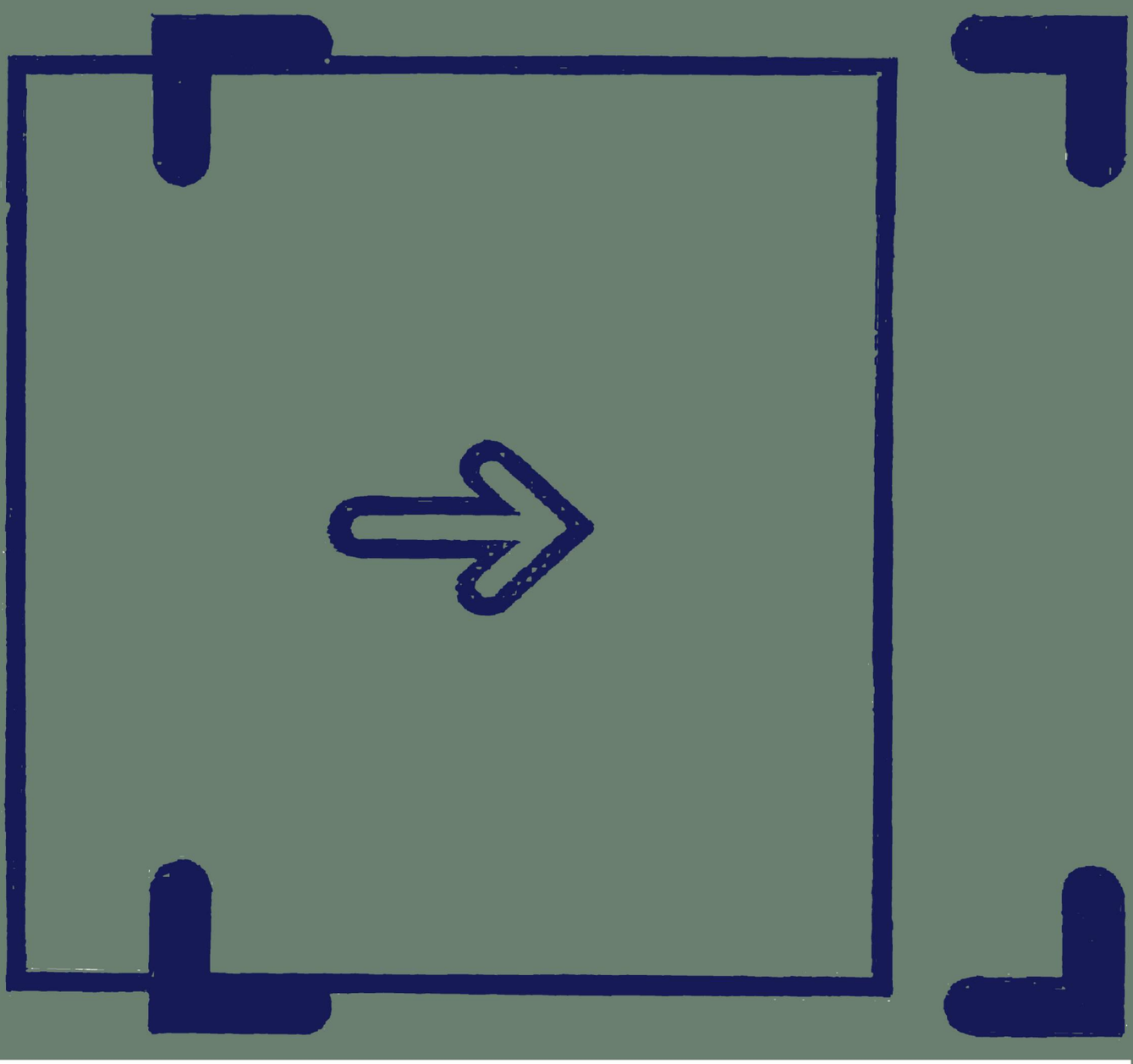
A. SHEPELEV

Glazing Practice



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GLAZING PRACTICE

А. М. Шепелев

СТЕКОЛЬНЫЕ РАБОТЫ

Москва «Высшая школа»

A. SHEPELEV

Glazing Practice

MIR PUBLISHERS MOSCOW

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Preface

This book has been produced to fill a long-existing need for a simple, concise, and complete treatise on working with glass.

It is written in simple, straightforward language, and many actual on-the-job practices are well illustrated. Each of the book's eleven chapters describes in detail every aspect of a group of related subjects.

The volume contains a description of all tools, equipment, and materials required for the cutting, installation, and repair of glass and glass articles.

Here, you will find complete and detailed instructions that will enable you to do a good-looking, professional job, even without previous experience.

With over 80 illustrations, the book makes even the most complex procedures clear. Each illustration shows in easy-to-follow detail just what step to tackle next on any job and how to tackle it. In many instances, you can do a complete job by just following the step-by-step illustrations, without ever referring to the text.

It is hoped that the book will be a welcome and valued aid to glazier apprentices, vocational education students, home owners, and many others.

Chapter One

Purpose of Glazing. Window Components

1. Purpose of Glazing

Almost any residential, office, public, or industrial building needs natural lighting. This purpose is served by windows, monitors, roof lights, etc. Naturally, provision should be made for letting light in and keeping the weather out. This is where glazing comes in.

Window openings should be placed so as to ensure maximum illumination (and ventilation for that matter) at minimum thermal losses. Yet, long-time exposure to sun rays may overheat the rooms in summer, which is hardly a healthy practice. Also, rooms with too many windows are rather difficult to keep warm in winter, which is a serious drawback as regards both thermal comfort and heating bills.

The illumination intensity necessary for visual comfort in residential, office, public, and industrial buildings is specified in relevant standards.

Depending upon the type of building and climatic conditions, window openings may have single, double, or triple glazing, or be glazed with multiple glass units, glass blocks, or specially shaped glass.

2. Window Components

The two principal parts of a window are the frame and the sash. The frame is the outer part of the window which is solidly fixed to, or built into, the wall and supports the sash. The sash carry the glass and may be fixed in position (in which case we speak of fixed sash) or may be

arranged to open*. The frame consists of four principal parts: the two vertical side members called the jambs, the horizontal member at the top called the head, and the horizontal member at the bottom called the sill. There may be one or more sash in a frame arranged in various ways, as described later in this article.

The sash is usually rectangular and consists of two side members called the stiles, a top member called the top rail, and a bottom member called the bottom rail. It may carry one light or pane of glass or may be subdivided by means of vertical and horizontal members, called muntins, to carry several lights of glass.

Sash and frames can be made of wood, metal, reinforced concrete, or plastics and come in a variety of shapes and sizes. In recent years, composite wood/aluminium windows have been finding ever increasing application. There exist single-, double-, and multiple-casement windows, with or without ventilators. Folding windows (as casement windows are sometimes referred to) are often equipped with fanlights (either fixed or operable) separated from the casements by a transom.

Rabbets of various depth and width are cut in the stiles and rails of a sash to accommodate a pane of glass. They may be plain or stepped. Glass is held in position by glazing sprigs and fixed by means of putty or glazing beads of various shape (Fig. 1*a* through *d*).

In casement windows, each light of glass is carried by a casement of its own. Casement sash are often arranged in pairs, two narrow sash being used instead of one wide sash. Here, the frame may be subdivided by a vertical member called the mullion. The position of the sash in the frame or opening is specified by the designer. Rabbets of appropriate width and depth are cut in the frames to house the sash.

Of late, what may be called double casements consisting of two casement sash hung on the same hinges have been gaining in popularity. Here, the inner sash is additionally hinged to the outer one, and the two sash are held together

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* Sash which are hinged on one side are called casements.— *Translator's note.*

by screws. Lights of glass are placed on the inside with the inner sash and on the outside with the outer sash. The entire casement is carried by a single frame (Fig. 1*e*).

The sash should be made of dry materials. The rabbets should be equally deep to ensure the desired contact between

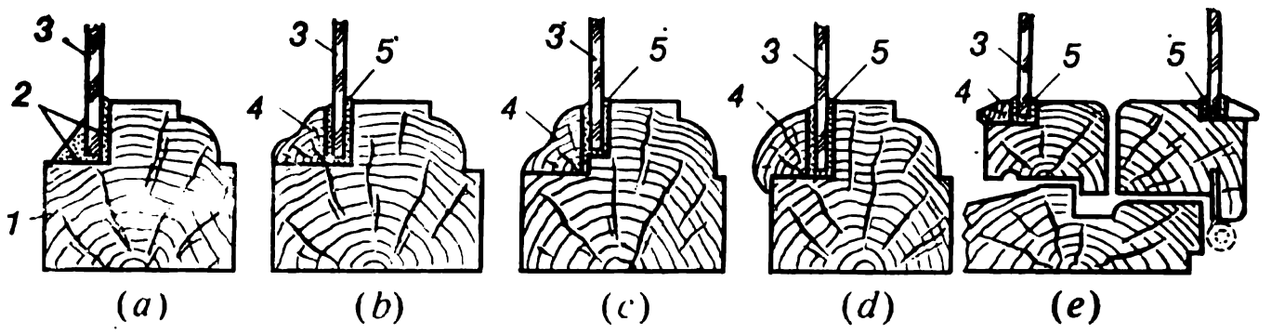

Fig. 1. Panes of glass fixed in the rabbets of window sash (*a*) by bed and face putty; (*b*) by bed putty and glazing bead; (*c*) by bed putty and glazing bead in a stepped rabbet; (*d*) by bed putty and glazing mould; (*e*) by bed putty and glazing beads in a double casement; (*1*) rail; (*2*) rabbet; (*3*) pane of glass; (*4*) glazing bead; (*5*) glazier's putty

the glass and the sash and also to save putty. The casements should fit tightly to keep rainwater from leaking in.

The sash should be given a coat of drying oil and allowed to dry. It will also be a good idea to give them a coat of paint. Glazing beads should likewise be coated with drying oil or paint and fixed firmly to the sash.

Sash and casements should be stored indoors (a suitable barn will also do) stacked on pads and covered to protect hem from water and dirt.

Chapter Two

Materials

3. Properties and Types of Glass

Properties. Major properties of glass are density, strength, hardness, brittleness, thermal conductivity, thermal stability, and optical properties.

Density is defined as the mass per unit volume of a substance. It depends on the chemical analysis of glass and may range from 2.2 to 7.5 g cm^{-3}. To some extent, it depends on temperature, falling down as the temperature rises.

Strength has to do with the ability of a material to resist load in compression, tension, etc. For glass, the ultimate compressive strength ranges between 500 and 2 000 MPa, and the ultimate tensile strength, between 35 and 100 MPa.

Hardness is the ability of a material to resist local penetration by a harder material. The Mohs hardness of glass is usually 7, although some types of glass may have a hardness of 5 to 6 on the Mohs scale.

Thermal conductivity gives a measure of a material's ability to conduct heat. It is numerically equal to the number of watts passed through an area of 1 m^2, 1 m thick under a temperature difference of 1°C between the two sides. The thermal conductivity (or *K*-value) of glass equals 0.74 W $m^{-1}°C^{-1}$.

Thermal expansion refers to an increase in linear dimensions of a heated body. Quantitatively, it is expressed in terms of the coefficient of expansion which is rather low for glass, being around 8.8×10^{-6} per degree Celsius.

Thermal stability is the ability of a material to sustain sudden changes in temperature without destruction. It plays an important role in construction, because there always exists a substantial temperature difference between the interior and exterior parts of structural members. Thermal stability is customarily expressed in terms of the limit of temperature to which a specimen can be heated without loosing its strength upon sudden cooling. For ordinary glass, this temperature is from 80 to 90°C. The thermal stability of glass mostly depends on its chemical composition. For example, quartz glass can sustain a temperature drop of up to 1 000°C.

Optical properties of glass include light transmission (usually expressed in terms of the transmittance), light absorption (this is the inverse of light transmission, sometimes given by the absorption coefficient), refraction (usually given by the refractive index), and reflection (expressed in terms of the reflectance). Clear window glass transmits

about 88% of incident light. To make glass highly transparent, the amount of staining impurities in the raw materials should be kept to a minimum. The light transmission of glass can be improved by giving it a high polish. Scratches and dirty spots markedly spoil the transparency. It should also be noted that transparent glass transmits all colours of the spectrum equally well.

In construction practice, use is generally made of clear window glass, plate glass, wire glass, figured glass, glass blocks, multiple glass units, and structural glass shapes.

According to surface quality, flat glass may be classed as polished or unpolished (ground). It may be tempered, annealed, or chemically (or otherwise) strengthened. A special type of glass is wire glass—rolled flat glass having a layer of meshed wire incorporated approximately in the centre of the sheet. Glass may be plain or coloured. Also, it may be smooth, figured, or bent.

Glass sheets should be rectangular in shape and have a uniform thickness and flat surface. They may be slightly curved lengthwise and still be acceptable, but the sag should not exceed 0.3% of the sheet's length. The sheet surface should be adequately smooth and free from iridescent and dull spots or similar defects. The edges should be straight with unbroken corners free from spalls and cuts. Each sheet should be uniformly annealed (if at all). Otherwise, the glass will refuse to break along cuts. Window glass may have a waviness, provided it does not distort vision and is noticeable only when viewed at an acute angle or in reflected light. Window glass may also contain a small number of transparent (air) or opaque (alkaline) bubbles. The quality of glass is adversely affected by the presence of unfused particles, scratches, and striae visible in passing light.

The requirements that a particular type of glass is to meet can be found in appropriate standards.

Types of Glass. In building construction, use is generally made of flat glass, glass blocks, multiple glass units, and various glass shapes.

Flat glass. Clear window glass (or sheet glass, as it is also called) is used for glazing various buildings and structures. The leading particulars of commercially available Soviet-made glass can be found in Table 1.

Finished glass is packed in boxes and containers on which the number of sheets and the area in square metres are indicated.

The dimensions quoted in Table 1 refer to quantity-pro-

Table 1. Leading Particulars of Clear Window Glass

Sheet thickness, mm	Length and width, mm		Light transmittance
	minimum	maximum	
2	500×400	1 300×750	0.87
2.5		1 550×750	
3	600×400	1 800×1 200	0.85
4		2 200×1 300	
5		2 200×1 600	0.84
6		2 200×1 600	

duced glass. Also available are glass sheets which are precut to suit customer's requirements. In Soviet practice, precut glass is available in widths from 275 to 925 mm and in lengths from 320 to 1 880 mm, the thickness being the same as given in the table. Precut panes of glass are used to glaze standard windows and balcony doors. They need not be cut on the job and require only minor trimming, which markedly cuts down waste and improves labour productivity.

Plate glass, both *polished* and *unpolished*, is employed for glazing shop-windows and also window openings in exhibition halls, cafes, restaurants, railway terminals, airports, factory buildings, etc. Polished glass transmits more light than unpolished plates.

Variations in thickness may exceed 0.2 mm for both polished and unpolished glass, depending on the plate thickness. Plate glass is shipped in boxes of max. 70 m^2 each.

The standard thickness of Soviet-made unpolished plate glass equals 6.5 mm. Unpolished plate glass is sold in the following sizes (mm): 3 950 × 2 950, 2 950 × 2 950, 2 950 × 2 650, 2 950 × 2 350, 2 950 × 2 200, 2 950 × × 2 050, 2 950 × 1 950, 2 950 × 1 750, 2 650 × 1 950, 2 350 × 1 950, 2 200 × 1 950, and 1 950 × 1 750. The

transmittance of unpolished plate glass is around 0.84. This kind of glass is available in two grades according to the amount of blemishes.

Soviet-made polished plate glass comes in the following sizes (mm): 4 450 × 2 950, 3 950 × 2 950, 2 950 × 2 950, 2 950 × 2 650, 2 950 × 2 350, 2 950 × 2 200, 2 950 × × 2 050, 2 950 × 1 950, 2 950 × 1 750, 2 650 × 1 950, 2 350 × 1 950, 2 200 × 1 950, 2 000 × 1 380, 1 950 × × 1 750, 1 940 × 1 450, 1 940 × 1 400, 1 450 × 1 340, and 1 380 × 1 340. The standard thickness of all plate-glass sizes is 6.5 mm, with the exception of plates measuring 4 450 × 2 950 mm and 3 950 × 2 950 mm whose thickness is 8 mm. Plates less than 2 000 mm long may be made 5.5 mm thick. The light transmittance varies from 0.83 for glass 6.5 and 5.5 mm thick to 0.80 for plates 8 mm thick.

Rolled figured glass is a kind of glass in which the vision is more or less obscured either by the roughened surface produced in rolling or by the impression of a large variety of designs in one or both surfaces of the sheet. It is used for glazing windows, doors, and partitions. Figured glass may be plain or coloured. The colour may be produced by adding staining agents to the batch or by depositing a film of various oxides.

Soviet-made figured glass is sold in sheets 400 to 1 600 mm wide, 600 to 2 200 mm long, and 3, 4, 5 and 6 mm thick. On request, standard sheets may be precut at the factory.

Wire glass is rolled flat glass having a layer of wire mesh placed approximately in the centre of the sheet. The glass is produced with processed, figured, and polished surfaces. It is used in residential, office, public, and industrial buildings to glaze monitors, roof lights, balcony and stair railings, lifts, and other components subjected to vibration and various dynamic loads, including impacts. Clear wire glass is available in sheets 400 to 1 500 mm wide, 1 200 to 2 000 mm long, and 5.5 mm thick. Coloured wire glass sheets have a maximum length of 1 500 mm, a maximum width of 800 mm, and a maximum thickness of 6 mm. Standard sheets may be precut at the customer's request.

Uviol glass which can transmit as much as 25% of incident ultraviolet rays is fabricated from batches having a

reduced metallic-oxide (iron, titanium, and chromium) content. It is commercially available in sizes from 250 × 250 to 2 000 × 2 000 mm, 2 to 6 mm thick. Uviol glass is mostly used for health farms, sanatoria, solaria, roofed swimming pools, green houses, and the like. Uviol glass is subject to ageing—it grows yellow with time and transmits less ultraviolet rays.

Heat-absorbing glass is a special coloured glass formulated to screen substantially the infrared portion of the solar spectrum without materially reducing visible transmittance. This effect is achieved by increasing the percentage of metallic oxides (iron, cobalt, nickel, etc.) in the batch or by giving the glass a coat of suitable metallic oxides. The colour of heat-absorbing glass may vary from greyish-blue to bluish-violet, depending on the type of oxide used. Heat-absorbing glass is widely used for glazing purposes in hot climatic regions. Soviet-made glass is commercially available in sizes from 250 × 250 to 2 000 × 2 000 mm. The standard thickness is 6 mm, irrespective of the sheet size.

Diffusing glass is used where light is to be passed with the vision partially or completely obscured. The two most common varieties are opal and matt glass. Diffusing glass is also available in a variety of colours. Standard sizes of Soviet-made glass are from 250 × 250 to 1000 × 1 800 mm, the thickness being from 3 to 6 mm.

Flat coloured glass is fabricated by adding small percentages of certain metal compounds to plate- and sheet-glass batches. It may have a smooth, corrugated, or patterned surface on one or both sides. Coloured glass is mostly employed for kindergartens, amusement parks, exhibition halls, and the like. It comes in a variety of sizes, the standard thickness being 3 mm.

Flat tempered glass features a high mechanical strength and heat resistance. It is employed for glazing shop windows and show-cases. Also, it is an excellent choice for glass doors, ceilings, partitions, and other components which must stand up well to impact loads. Glass products to be tempered are fully shaped in advance, because tempered glass cannot be cut, ground, drilled, or otherwise worked. In Soviet practice, it is sold in five standard thicknesses from 4 to 6 mm at 0.5-mm intervals.

Radiation-absorbing (*X-ray*) *glass* is available in Soviet practice in the form of rectangular and round sheets. Rectangular sheets have a length of 146 to 600 mm and a width of 134 to 500 mm. Round sheets are 30 to 250 mm in diameter. The standard thicknesses of Soviet-made rectangular and round sheets of X-ray glass are 10, 15, 20, 25, and 50 mm. Sheets of X-ray glass have polished surfaces, ground sides, and chamfered edges.

Glass products. *Glass blocks* are hollow translucent masonry units formed by fusing, at a high temperature, two sections which have been cast separately. Their primary function is to transmit light through walls and thereby to replace windows. Glass blocks may be plain and coloured.

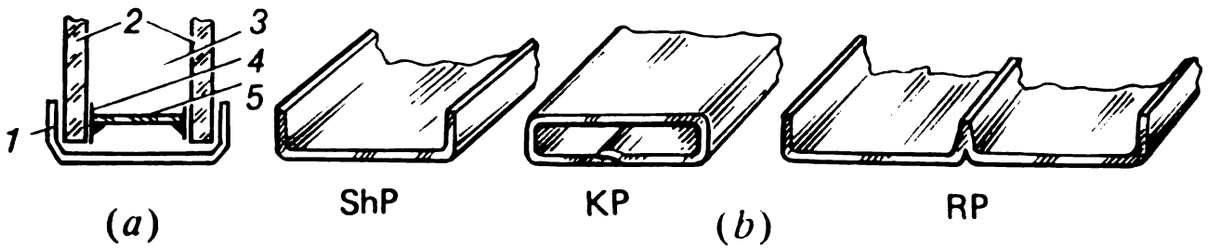

Fig. 2. Multiple glass unit and structural glass shapes
(*a*) single-space multiple glass unit; (*b*) structural glass shapes (ShP—channel, KP—box section, RT—ribbed section); (*1*) perchlorvinyl film; (*2*) glass sheets; (*3*) air space; (*4*) copper coating; (*5*) lead strip

Various patterns (five of them in Soviet practice) are available for the exposed faces. Soviet-made glass blocks have patterns on the interior surfaces, and their exposed surfaces are left smooth to permit easy cleaning. In the USSR, standard glass block sizes are 294 × 194 × 98, 244 × 244 × 75, 244 × 244 × 98, and 194 × 194 × 98 mm. These blocks range from 2.8 kg to 4.3 kg in mass.

Glass lenses, *prisms*, and *tiles* offer a higher mechanical strength than hollow glass blocks which are not suitable for carrying loads other than their own weight. These units are used as pavement lights in floors over basements, as roof lights in industrial buildings, supermarkets, stadiums, etc. In Soviet practice, solid glass units are manufactured in two standard sizes, namely 200 × 200 and 250 × 250 mm. The three standard thicknesses are 25, 50 and 100 mm.

Multiple glass units (Fig. 2*a*) are assembled of two or more sheets of glass joined around the periphery in such a way

that an air space or spaces are left between the sheets. The methods for constructing the marginal seal vary widely with the different manufacturers. In Soviet practice, the component sheets are bonded by fusion or by using a suitable adhesive. Soviet-made multiple glass units may have one, two, or three air spaces, the distance between the component glass sheets being 15 and 20 mm. Depending on their purpose, multiple glass units may be built up of clear window or plate glass (both polished and unpolished). The standard thicknesses are 22, 24, 26, 28, 30, 32, and 34 mm.

The dimensions of multiple glass units are usually specified by the customer, the maximum size being 2 300 × 1 900 mm and the minimum size, 300 × 300 mm.

As compared with ordinary flat glass, multiple glass units can span larger (by 25 to 30%) openings, have a lower thermal conductivity and better sound-insulating properties, and do not freeze, mist up, or collect dirt on the inner surfaces. Multiple glass units can be fitted into wooden, metal, or plastic frames.

Multiple glass units may also be composed of two sheets of glass interleaved with a spacer of glass-fibre material to diffuse light. The component glass sheets are bonded together with an appropriate sealing compound, and the joint is then covered around the periphery with a water-resistant elastic tape.

Multiple glass units like that are used for glazing windows, monitors, roof lights, and partitions where it is necessary to secure diffused lighting and to reduce solar radiation. They are fitted into wooden or metal frames on elastic pads and sealed around the periphery with rubber gaskets or nonsetting water-resistant mastic.

Structural glass shapes are rolled from plain or coloured glass on special machines and then cut to size. They may have smooth, corrugated, or figured surfaces and be reinforced with meshed wire. Translucent filler elements built up of glass shapes (self-bearing walls, partitions, roofs, etc.) are widely used in civic and industrial buildings and farm structures.

In Soviet practice, the most-used shapes (Fig. 2*b*) are box sections, channels, and ribbed sections. Their leading particulars can be found in Table 2.

Table 2. Leading Particulars of Soviet-Made Structural Glass Shapes

Type	Type designation	Width, mm	Height, mm	Thickness, mm	Maximum length, mm
Channels	ShP-240	244	35	5.5	3 600
	ShP-250	250	40, 50	5.0	5 000
	ShP-300	294	35, 40, 50		
	ShP-500	500	40, 50	6.0	3 000
Box sections:					
— single-jointed	KP-1-250	244	50	5.5	3 600
	KP-1-300	294			
— double-jointed	KP-2-250	244	55		
	KP-2-300	294			
Ribbed sections	RP-600	594	50	5.5	3 600

For structural glass shapes, the difference between the actual and standard dimensions should not exceed the following values (mm):

Length and width	±5
Height	±3
Thickness	±0.5
Joint thickness (for box sections)	±5
Corner radius	±1
Width at root of middle rib (for ribbed sections)	±5

Transportation and Storage. In Soviet practice, flat glass and structural shapes are factory-packed in wooden boxes or containers for transportation and storage.

On the job, the storage area should be carefully levelled, dewatered, and cleared from snow and ice in winter. It should have a reliable firm foundation. Glass packed in boxes and containers should be stored on suitable racks in a slightly inclined position. The amount of glass per rack is specified in appropriate standards. The boxes and containers are installed with their covers facing outside. Where no sheds are available, the glass should be covered with roofing paper or any other suitable material.

Plate glass is supplied according to customer's specifications.

To avoid cutting glass on the job, use is generally made of precut panes delivered in containers.

4. Materials for Glazier's Putty, Glazing Compounds, Mastics and Grout

Glazier's putty is a plastic material used for bedding glass in lights and for making a weatherproof fillet of face putty outside the glass, holding it to the frame. It is made of whiting mixed with drying oil with or without some additions*.

Whiting is essentially crushed chalk—a soft, fine-grained carbonaceous rock composed of natural calcium carbonate (if necessary, calcium carbonate may be produced artificially). In Soviet practice, three grades of lump chalk, namely MK1, MK2 and MK3, are used in the building industry

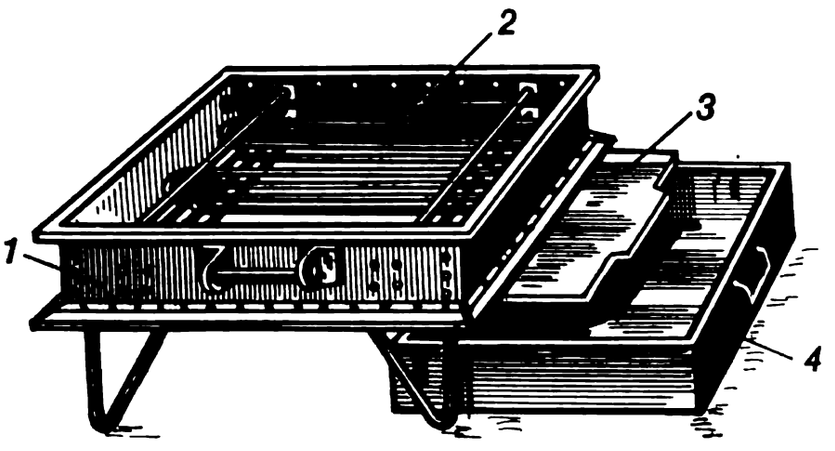

Fig. 3. Electric range for drying chalk
(*1*) casing; (*2*) heating tubes; (*3*) slide gate; (*4*) box

for various purposes. Lump chalk is ground to a fine powder passing through sieve No. 02 (980 meshes per square centimetre). Crushed chalk (grades MM1, MM2, and MM3) is used for the same purposes as lump chalk. It should likewise pass through sieve No. 02 with 1% oversize for the first

* For putties based on other materials, the usual name given is glazing compounds.—*Translator's note.*

quality class, 3% oversize for the second quality class, and 6% oversize for the third quality class.

The quality of glazier's putty markedly depends on the milling fineness and moisture content of whiting. The maximum permissible moisture content is 5%. Moist chalk is dried on special electric ranges (Fig. 3). The range capacity is up to 240 kg of chalk per shift at an initial moisture content of 10 to 15%.

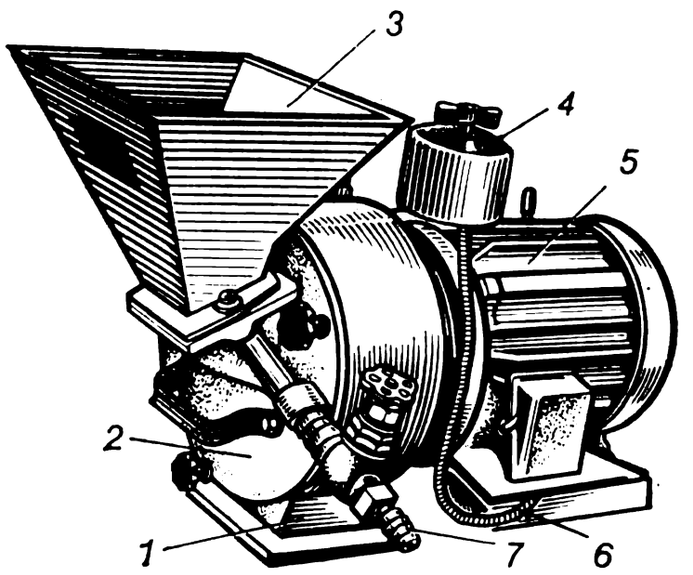

Fig. 4. Chalk mill
(*1*) outlet; (*2*) milling chamber; (*3*) feed hopper; (*4*) switch; (*5*) electric motor; (*6*) wire; (*7*) water hose coupling

Lump or coarsely ground chalk is additionally pulverized in chalk mills. The chalk mill of Fig. 4 has an outlet *1*, a feed hopper *3*, and an electric motor *5*. Lumps of chalk are fed through the hopper *3* into a milling chamber *2* where they are crushed to a fine powder. As it passes through gaps between the rotor blades and the casing, the chalk is pulverized further. The capacity of the chalk mill is from 300 to 400 kg per hour.

Before application, whiting is strained through a power screen (Fig. 5) whose capacity runs into 1 500 kg per shift.

Drying oil serves as a vehicle for whiting in glazier's putty. Drying oils are many and varying, the basic types being *natural drying oil* based on vegetable oil (linseed oil, sunflower-seed oil, hempseed oil, etc.), semi-natural drying oil, and synthetic drying oil. The semi-natural and synthetic types contain 55% downwards vegetable oil, where-

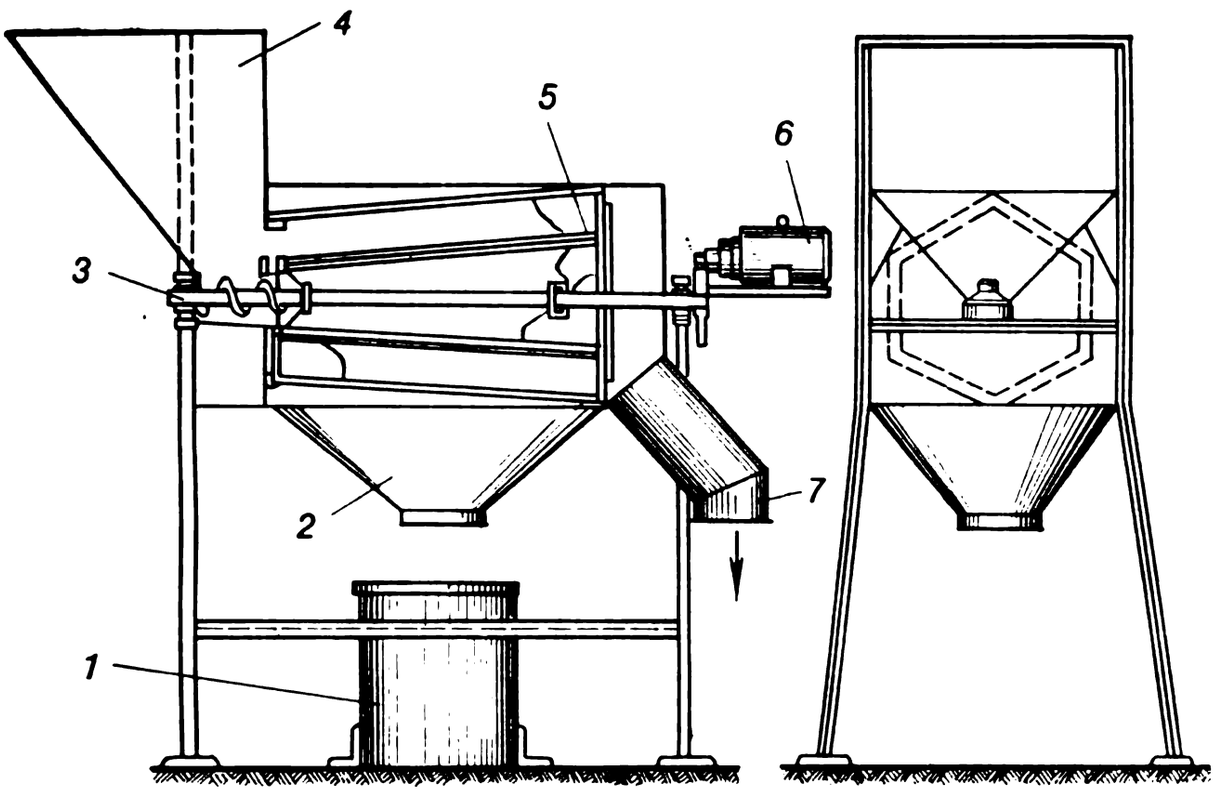

Fig. 5. Power screen for chalk
(*1*) collecting box for screened material; (*2*) hopper; (*3*) auger; (*4*) feed bunker; (*5*) drum frame; (*6*) electric motor; (*7*) oversize outlet

as natural drying oil contains up to 95% vegetable oils.

Semi-natural drying oil is, in effect, a mixture of a vegetable oil and a thinner. Some drying oils of this type contain up to 90% vegetable oil and are suitable for making glazier's putty. A special kind of semi-natural drying oil is composed of oxidized vegetable oil and driers dissolved in white spirit.

The vegetable-oil content of *synthetic drying oils* (for example, shale oil) seldom exceeds 35%. Most types, however, use no vegetable oil at all.

Various *pigments* and *paints* are sometimes used to impart colour and strength to the putty. These are added as powders or liquids (pigments mixed with drying oil). Powders are employed for purely colouring purposes, while liquid paints supply both colour and strength. The most common materials are zinc white, white lead, iron minium (red ocher), and red lead. White and red lead are particularly strong but, being toxic, may only be used outdoors or in well-ventilated rooms. Paste paints are stored in tightly stopped vessels, and powders, in barrels or bags.

Petroleum bitumens are used for paving, roofing, and some other purposes. Sometimes, they are also employed as a vehicle for glazing compounds and mastics. In Soviet practice, the following grades find application: BN50/50 (with a softening temperature of 50°C), BN70/30 (with a softening temperature of 70°C), and BN90/10 (with a softening temperature of 90°C). The most-used grades of roofing bitumen are BNK-45/180, BNK-90/40, and BNK-90/30.

Portland cement—a finely ground greyish-green powder—is the most widely used hydraulic binder in building. It is available in several grades in terms of its ultimate compressive strength at the age of 28 days: M 400, M 500, M 550, M 600, etc.*.

A grout of portland cement mixed with sand and water is sometimes employed for glazing purposes. It is a rapid-setting material and must be used within an hour.

Other materials used to prepare glazing compounds are wood resin, rosin, water glass, caustic magnesite, magnesium chloride or sulphate, and casein.

5. Materials for Holding Glass in Sash

Nails of various size are used to hold panes of glass in place (small nails or brads) and to fix glazing beads to the sash (large nails).

Wood screws of various length are employed to fix wooden glazing beads to the rabbeted sash.

Wire up to 1.5 mm in diameter serves to make glazing sprigs holding the glass in the wooden sash while the putty is being placed.

Glues and *cements* of various kind are widely used to secure rubber pads to the glass.

Pads, *gaskets*, and *weather strips* are customarily manufactured of rubber. Rubber may sometimes be replaced with kapron (Soviet-made brand of nylon), polystyrene, polyethylene, polyacrylate, and some other synthetic materials of adequate strength and durability. These elements are mostly used to secure plate glass (some most common Soviet-made

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* The numerals refer to the compressive strength in kgf cm^{-2} — *Translator's note*.

rubber gaskets and pads are "Agat", RTs-1, RTs-5, RP-1, and RU-1).

Glazier's points, clips, springs, and wedge-operated clamps are used to hold glass in metal and reinforced concrete frames. Glazier's points are small square, triangular, or diamond-shaped pieces of sheet metal (usually plain or galvanized steel). They may also be round, though much less frequently. Glazier's points are 20 to 25 mm long and 4 to 6 mm thick. Clips, springs, and wedge-operated clamps are manufactured of galvanized roofing steel.

Metal glass stops are generally made of steel or duralumin angles or U-shapes.

Pads used in bedding structural glass shapes are manufactured of solid or sponge cold-resistant rubber, plasticized PVC, or similar materials. They come in the form of shoes put on the ends of box sections and channels or as strips to seal the joints between the glass elements or between the glass and the wall. Similar pads may also be useful in fixing plate glass.

Chapter Three

Preparation of Glazier's Putty, Glazing Compounds, Mastics, Grout, and Sealants

6. Preparation of Glazier's Putty

As mentioned in the previous chapter, glazier's putty is an oily, plastic, paste-like material used for holding glass to the sash. Once applied, it sticks firmly to bases of wood, metal, or other materials. The material, which is also referred to as painter's putty in the trade, may be applied hot or cold. Semiliquid bed putty is placed on the rabbet of the sash before pressing (or bedding, as is customary to say) the glass. Its denser variety known as face putty is used for face-puttying—making a triangular fillet of glazier's putty on the exposed surface of the glass—and for back-

puttying—forcing putty into any spaces which may be left between the edges of the rabbet and the glass.

Glazier's putty should meet the following requirements:

— it should have a sufficient plasticity. A thread rolled of sound putty will show well-pronounced necking before rupture in tension, while that of unsound putty will break without any necking;

— it should be adequately soft, so that it can readily be placed on rabbets, glass, and glazing beads, and stick well to glass, wood, metal, or concrete, filling all spaces between the edges of the rabbet and the glass. On the other hand, putty should not stick to the hands. Otherwise, it will be very difficult to work with, slowing down the entire glazing process;

— it should readily come off a putty knife, be easy to spread, and show a smooth, brilliant surface after it has been shaped with the knife;

— it should offer a substantial resistance to water, frost, and heat and be able to dry out within three days (this is particularly important in winter);

— it should neither peel off the rabbets in application nor crack or crumble after drying out;

— it should retain some elasticity upon drying to allow the glass to move if the sash deform.

Glazier's putty which fails to meet the above requirements should be rejected.

Putty to be applied by a gun should be soft enough for it to be squeezed out without exerting too much force.

Glazier's putty based on natural drying oil is used in glazing permanent buildings with a rated service life of at least 10 years. Putty prepared with oxidized vegetable oil and driers dissolved in white spirit is only applicable to temporary structures whose service life is at least 2 years.

For metal and reinforced concrete sash, use is made of putty based on natural drying oil with the addition of zinc white or iron minium in dry or, preferably, liquid or paste form to promote the oxidation of the oil*.

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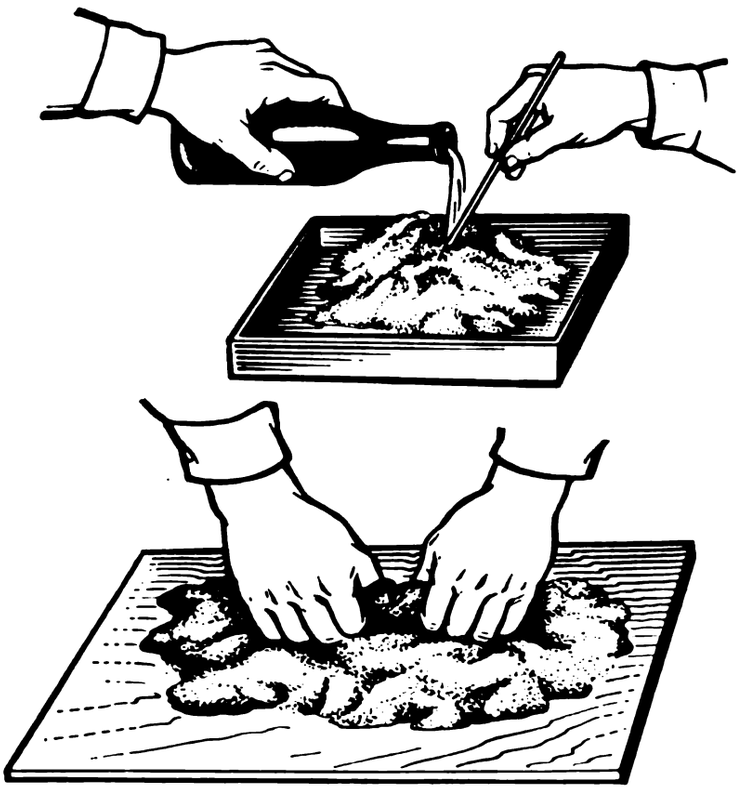
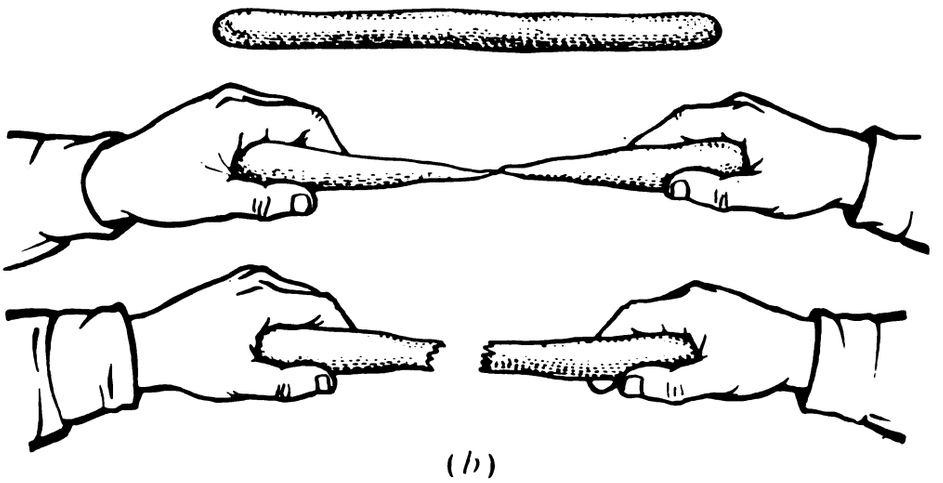
* Special putty for metal sash is on the market and, if of good quality, is preferable to ordinary putty to which zinc white or red ocher has been added.—*Translator's note.*



(*a*)



(*b*)

Fig. 6. (*a*) Preparation of putty and (*b*) quality control

Glazier's putty can be made manually (for small jobs) or in mixers.

To prepare putty *by hand*, proceed as follows. Put some screened whiting on a tray, make a depression in the centre, fill it with drying oil, and mix the ingredients thoroughly with a putty knife or a spatula. If necessary, add more

whiting until the paste-like mass becomes difficult to mix further with the given tools.

The putty thus prepared is only suitable for bedding purposes. It is insufficiently thick, keeps sticking to the hands, and, if used as face putty, will flow off the rabbet. Its quality can be improved by processing the material in a paint grinder.

To prepare material of face-putty quality, still more whiting needs to be added to the paste. To this end, spread some whiting into a layer 1 to 2 cm thick on a sheet of galvanized roofing steel or plywood, and roll it by hand until it picks up enough whiting and stops sticking to the hands, cleaning the fingers and palms of any stuck material. Knead-

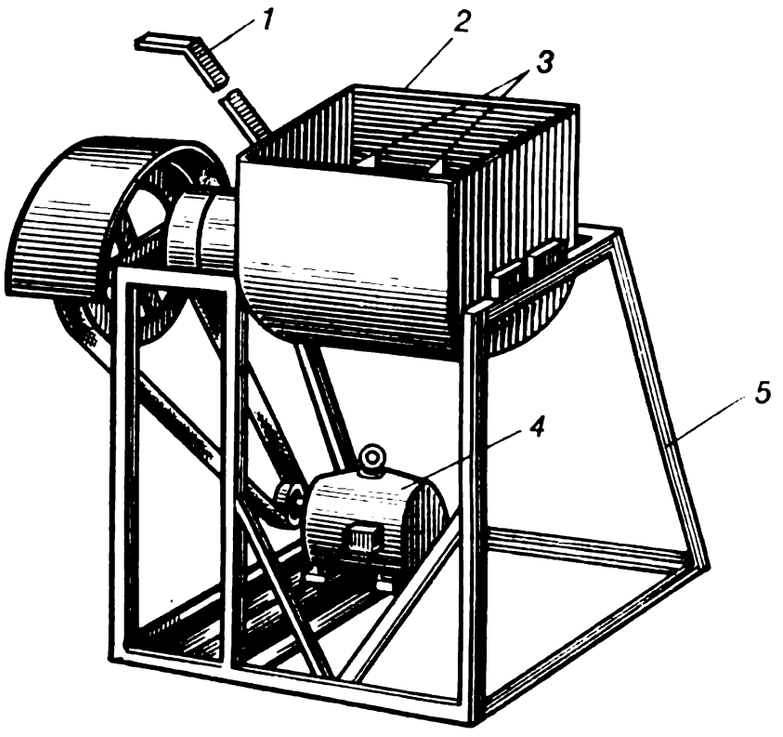


Fig. 7. Double-blade mixer
(*1*) handle; (*2*) bunker; (*3*) blades; (*4*) electric motor; (*5*) frame

ed in this way, the putty will become a homogeneous mass, free from pockets of oil or whiting. Roll some of the putty into a thread and give it a pull at the ends to make sure that the material is sound (Fig. 6*a* and *b*).

Where dry pigments are to be added, mix them first with the whiting and then prepare the putty as prescribed above. Liquid or paste paints should first be mixed with the drying oil.

Putty should be stored in bags or covered with polyethylene film to prevent it from premature drying.

Where large quantities of glazier's putty are required, *power mixers* may come in handy. The double-blade mixer of Fig. 7 has a bunker *2* which can be tilted by a handle *1* after the batch has been mixed. The bunker houses two blades *3* rotating in the opposite directions. One of the blades rotates at 125 rpm, and the other, at 60 rpm. The blades are driven by an electric motor *4* whose rotor develops a rotational speed of 950 rpm. The mixer is mounted on a metal frame *5*. The total mass of the unit is 210 kg. The mixer has a capacity of 120 kg of putty per hour and can mix a batch within 20 min, depending on the required thickness and homogeneity of the putty.

Putty is mixed in the following manner. Pour drying oil (in the amount required) into the bunker, add some whiting, and turn on the mixer, gradually adding the remaining whiting as the stuff is agitated. In cold weather (especially at subzero temperatures), putty thickens very quickly and becomes unfit for use. Thick putty is very difficult to work into the rabbets, and it fails to stick to the rabbets and glass. In view of this, it will be a good plan to heat the putty to about 50°C before application.

Glazier's putty should be prepared in amounts large enough

Table 3. Materials Requirements per 10 kg of Putty

Materials	Quantity (parts by mass) for			
	whiting putty	white lead putty	red lead putty	iron putty
Drying oil	2.1	1.7	1.5	1.4
Screened whiting	8	6	6.5	7
White lead powder	—	2.4	—	—
Red lead powder	—	—	2.1	—
Iron minium powder	—	—	—	1.7

for 2- or 3-day's work. Table 3 gives approximate materials requirements per 10 kg of putty with allowance for possible losses.

7. Preparation of Glazing Compounds, Mastics, and Sealants

Glazing Compounds. Glazier's putty is sometimes replaced with glazing compounds based on mineral and organic binders. Some of these will be discussed in this article.

For *bituminous compounds*, the most common compositions are given in Table 4.

Table 4. Composition of Bituminous Compounds

Materials	Quantity (parts by mass)		
	formula 1	formula 2	formula 3
Type BN70/30 petroleum bitumen or mixture of type BN50/50 and BN90/10 bitumens	1.33	—	3.2
Extender	8.1	8.3	3.6
Coal-tar pitch	—	1.2	—
Portland cement	—	—	2.4
Thinner	1.33	—	1.3
Anthracene oil	—	0.12	—
Benzene, solvent naphtha	—	1.1	—

Various materials are used as extenders for bituminous glazing compounds, including portland cement, tripoli earth, whiting, ash, and thoroughly screened ground slag, limestone, and dolomite. The moisture content of the extender should not exceed 4%. For better quality, 10 to 15% asbestos may be added. The most-used thinners are kerosene, naphtha, petrol, benzene, and solvent naphtha.

A bituminous compound is prepared in the following order. Fill a tank or any other suitable vessel having a tightly fitting cover three-thirds full with bitumen (or coal-tar pitch) and make a fire to melt the material. As soon as the bitumen begins to foam, skim the froth to remove foreign particles coming to the surface. Continue heating the bitumen until it stops foaming. Then put out the fire, allow the material to cool down to 70 or 80°C, and stir in kerosene, naphtha, or petrol (or anthracene oil, benzene, or solvent naphtha in the case of coal-tar pitch) in small portions. Go on

stirring until the mixture becomes a homogeneous solution. Then empty the tank into a hermetically sealed vessel and use the solution cold as a vehicle for the glazing compound. The material can be stored for two to three months. To prepare the compound, add a suitable extender to the solution and mix the ingredients thoroughly to obtain a homogeneous friable mass.

The compound thus prepared is employed in glazing industrial buildings. In hot climate, high-melting bitumens should be used as the vehicle, and asbestos as the extender.

Adding chalk will not make black glazing compounds white. When they are used for glazing residential buildings, bituminous compounds are given a coat of nitrocellulose enamel. Bitumen cannot bleed through a paint like that, so the coat always remains white.

The amount of putty (in kg) per 10 m of rabbeted sash is specified in Table 5.

Table 5. Amount of Putty per 10 m of Rabbeted Sash

Type of putty	Bed and face puttying			Bed puttying
	rabbets 1×1.5 cm	rabbets 1×2 to 1.5×1.5 cm	rabbets 1.5×2 cm	
Whiting putty	1.5	1.53	2.3	0.9
White lead putty	1.61	2.14	3.22	1.26
Iron putty	1.73	2.3	3.45	1.35
Red lead putty	2.01	2.68	4.03	1.58
Bituminous compound	0.63	0.86	1.39	—

Note. Where no glazing beads are used, 0.013 kg of wire is required per 10 m of rabbeted sash.

A *glazing compound based on petroleum oil* consists of 12 parts (by mass) of calcium resinate to 7.2 parts of waste motor oil. Whiting is also added in the amount required to serve as an extender.

Calcium resinate is prepared by mixing 1 part (by mass) of rosin with 0.08 part of hydrated lime. To this end, heat

the mixture to 220°C at which temperature complete fusion takes place. Maintain the temperature at that level for about 30 min. After that, mix the calcium resinate thus prepared with motor oil and heat the mixture to 150°C. Wait till the mixture stops foaming. After the material has cooled down, add dry whiting strained through a close-meshed sieve, and stir the mixture as usual. The compound thus made is used in much the same way as ordinary whiting putty in glazing temporary structures.

A *rosin-oil compound* consists of 1 part (by mass) of rosin, 0.9 part of petroleum oil, 0.4 part of turpentine or kerosene, 0.3 part of hydrated lime, and 4 to 5 parts of whiting (in some compositions, whiting is replaced with dry iron minium).

This kind of compound is prepared in the following order. Crush rosin into small pieces and melt the crushed material in a metal tray or any other suitable vessel at a temperature of 120°C. Put out the fire and stir in turpentine or kerosene to the molten rosin in small portions. Empty the tray into a hermetically sealed vessel.

Then, add hydrated lime screened through the same mesh as whiting to the rosin solution and thoroughly stir the mixture. After that, add petroleum oil and whiting (or iron minium) while stirring the material continually. Mix the ingredients until a homogeneous mass of desired thickness is obtained.

A *magnesia compound* consists of 1 part (by mass) of caustic or calcined magnesite, 0.4 part of magnesium chloride (or sulphate) or man-made carnallite, and 2.5 to 3 parts of an extender (finely ground limestone, dolomite, quartz sand, or whiting passed through sieve No. 02).

To prepare the compound, mix magnesite with an extender and temper the mixture with water (22 to 25% by mass of the dry mixture).

For better plasticity, add 10 to 15% of talc mass as the extender. If magnesium chloride, magnesium sulphate, or carnallite are available in the form of prepared solutions, their density should equal 22° Baumé. Add the solution to the dry mixture in the amount sufficient for obtaining a plastic mass. The glazing compound should be used within 2 to 3 hours.

This kind of compound finds application in industrial and residential buildings.

A *casein compound* contains 1 part (by mass) of casein, 0.4 part of 50% lime putty, and 10 parts of finely ground whiting. It is prepared as follows. Put casein in a clean vessel and soak it in three times as much water heated to 60 or 70°C. Let the casein swell for 3 to 4 hours, stirring the water from time to time. Then, add lime putty to the swollen casein and stir the mixture for 1.5 to 2 hours. Finally, add whiting passed through sieve No. 02 to the casein glue thus made and pour water in the amount sufficient for obtaining putty of desired thickness.

The casein compound is subject to decay and may not be stored for a long time.

A *petroleum-oil compound* consists of 1 part (by mass) of lubricating grease or gearbox oil, 1 part of portland cement (with a compressive strength of at least 30 MPa), and 1.3 parts of ash. To make the compound, put lubricating grease or gearbox oil in a clean vessel and heat it to 100°C. Then, mix in sieved ash, stirring the mixture thoroughly. Finally, add cement in small portions and mix the ingredients thoroughly to obtain a homogeneous plastic mass. The compound is applied hot; if necessary, it may be heated from time to time in the course of application.

A *no-oil whiting compound* consists of 1 part (by mass) of kerosene, 1.45 parts of water glass having a specific gravity of 1.36, 4.4 parts of wood resin, 0.6 part of hydrated lime, 4 parts of fine sand, and 10 parts of whiting. As a point of departure, mix kerosene with resin and water glass in a suitable vessel. Then mix whiting with hydrated lime and sand in a separate vessel and add the mixture to the liquid, stirring the material into a homogeneous mass of desired thickness. The compound serves as a substitute for glazier's putty in temporary structures.

A *sand-and-whiting glazing compound* based on semi-natural drying oil (vegetable oil and driers dissolved in white spirit) is composed of 1.3 parts (by mass) of semi-natural drying oil, 4.4 parts of whiting passed through sieve No. 02, and 4.8 parts of fine river sand. To make the compound, mix whiting with sand, add drying oil, and stir the material until a homogeneous mass is obtained. The com-

pound thus prepared sticks well to rabbets and glass, offers substantial resistance to freezing, is impermeable to water, and shows an appreciable plasticity and workability. It is employed in glazing temporary structures.

An *asbestos-sawdust-cement glazing compound* contains 1 part (by mass) of cement, 0.2 part of fine sawdust, and 0.45 part of asbestos. Water is added in the amount required for proper workability. To begin with, mix sawdust with asbestos, add cement, and stir the ingredients into a homogeneous mixture. If necessary, add dry building paint (pigment) of desired colour. Then, temper the mixture with water until a mass of desired thickness is obtained. The compound sets quickly and should be used within an hour. It has an appreciable plasticity, offers a substantial resistance to water, and sticks well to metals and glass. This kind of compound finds application in glazing reinforced concrete frames and metal sash.

A *cement-sand glazing compound*, or *cement grout* as it is customarily called in building practice, is composed of 1 part of cement and 3 parts of sand. To prepare the compound, begin with mixing the dry ingredients. For better plasticity, add fine-fibred extenders (such as asbestos or slag wool). Then, temper the dry mixture with water to obtain a mass of desired thickness and use the material within an hour. Cement grout is generally employed in glazing reinforced concrete frames and metal sash. A major drawback of the material is its excessive stiffness which makes it difficult to place on vertical rabbets. The plasticity can be improved by using less sand, say, 1 or 2 parts of sand to 1 part of cement.

A *non-setting glazing compound* is mostly used to fill gaps between the frame and the sash when placing interior sash or fixing the sash so that they would not operate. This is a reusable material consisting of 6 parts (by mass) of cup grease (or lubricating grease where cup grease is not available), 14 parts of spindle or straw oil, and whiting passed through sieve No. 02.

To make the compound, put cup grease (or lubricating grease for that matter) in a metal vessel, heat it until it melts completely, and add spindle (or straw) oil, stirring the material into a viscous mass. Then let it cool, add whit-

ing, and knead the compound in the usual manner until a mass of desired consistency is obtained. The compound hardens on cooling, so it has to be kneaded continually or heated in a water bath. As an alternative, it may be prepared from whiting and lubricating grease alone. In this case, however it will have poor plasticity. The non-setting compound may be replaced with plasticine rolled into thin threads.

Mastics are complex solid or semi-solid waterproof materials exhibiting an appreciable adhesive ability. Applied hot or cold, mastics may be used as bed putty in glazing. They can be prepared in many ways; in this text, however, we shall only consider two most-used compositions.

A *waterproof mastic for sealing expansion joints in glass panels* contains 55 to 60 parts (by mass) of type BN70/30 petroleum bitumen, 20 to 25 parts of petrol or kerosene, 10 parts of asbestos, and 10 parts of talc. To make the mastic, put bitumen in a metal vessel, heat it until it melts completely, then put out the fire, and allow the liquid to cool down to 70 or 80°C. Next, mix petrol (or kerosene) with asbestos and talc and add the mixture to the cold bitumen, stirring the material thoroughly. The mastic should be stored in a hermetically sealed vessel and applied cold or heated to 50 or 60°C.

A *non-setting mastic for sealing expansion joints* is composed of 1.5 parts (by mass) of portland cement or fine whiting thoroughly mixed with 1 part of petrolatum. The petrolatum should preferably be heated for ease of mixing and better homogeneity.

Sealants or sealing compounds are synthetic fluids of plastic consistency which set immediately or some time after application, the setting being triggered by temperature or some other factors. They are prepared from liquid rubber (the base composition) and appropriate admixtures to impart desired properties. Sealants are laid over a joint surface to exclude water. In glazing, use is generally made of polysulphide (Thiokol) sealants available as pastes or liquids.

The basic components of a polysulphide sealant are a sealing paste (liquid Thiokol), a curing agent (a vulcanizing paste), a vulcanization accelerator, a filler, and an adhesion activator. The ingredients are mixed into a homogeneous

mass before application. The time limit to application (the setting time) of the sealant depends on the initial viscosity of the sealing paste, proportion of the curing agent, and ambient temperature.

In Soviet practice, polysulphide sealants are commercially available as three-part compounds consisting of 100 parts (by mass) of the base composition (sealing paste), 9.1 parts of the curing agent (vulcanizing paste), and 0.55 part of the vulcanization accelerator. The sealing paste is sold in 5-, 10-, 15-, 20-, 25-, and 50-kg galvanized-steel cans. The curing component comes in polyethylene containers, and the vulcanization accelerator, in double-walled polyethylene bags.

The most common Soviet-made grades are U-30M and UT-31. They can be cured at 18 to 30°C and have a setting time of 2 to 9 hours. The shelf life of the base composition (sealing paste) is twelve months for the U-30M sealant and six months for the UT-31 sealant, and that for the curing agent (vulcanizing paste) is twelve months for either grade. Other grades based on these two are also available (Table 6).

Table 6. Polysulphide (Thiokol) Sealants

Grade	Curing agent (vulcanizing paste), parts by mass		Vulcanization accelerator, parts by mass	Applied by	Colour
	No. 9	No. 15			
U-30M	5-9	—	0.1-0.6	putty knife, pressure gun and brush	black
U-30s	—	6.5-7.7	0.2-0.5		
U-30MES-5	7-12	—	0.3-1.0		
U-30MES-10	8-15	—	0.4-1.1		
UT-31	6-9	—	0.3-0.6	putty knife, pressure gun, brush, and pouring	light-grey
UT-32	9-12	—	0.4-0.8		
UT-34	10-15	—	0.4-1.0	putty knife, pressure gun, brush, and sprayer	grey
UT-35	5-10		0.1-0.8		

Sealing compounds should be thinned to faciliate their application by a brush, sprayer, or pouring. They are used

in placing plate glass on rubber pads or pads of other suitable materials, in filling the gaps between glazing beads and glass panes, and in filling the joints between structural glass shapes or other glass units.

8. Safety Precautions in Preparing Glazier's Putty, Glazing Compounds, Mastics, and Sealants

Store whiting, sand, cement, and asbestos in boxes, bins, barrels, or bags appropriately covered to avoid ingress of foreign objects. Store liquids (such as drying oil, thinners, and solvents) in hermetically sealed metal vessels (barrels, cans, etc.) at least 3 m away from heating appliances.

Allocate a special room for the preparation of putty, glazing compounds, and mastics. Rub some skin-protecting paste or cream into your hands before work.

NEVER smoke in the workshop!

Take used wiping rags, cleaning cloth, oakum, etc. soaked in kerosene, petrol, turpentine, or other solvents away from the workshop or put them in a tightly covered container where they will be unable to catch fire.

NEVER use open flame to melt bitumen or resin. Make sure that the tanks and kettles are set in brickwork and equipped with heavy lids which could readily be replaced should the molten material catch fire. Take care to do all melting outdoors in places assigned by fire authorities. In doing so, wear overalls, safety goggles, and gloves.

Check to see that the tanks and kettles are filled at most three-fourths full. NEVER bend over the boiling stuff.

Before solvents can be poured, put out the fire and allow the molten resin to cool down to 70 or 80°C.

Provide fire-fighting equipment near the melting stations. Make sure that all the workers know how to use it.

Heat mastics and compounds in water baths only. Use special cans with self-replacing lids to carry and store hot materials.

Handle electric heaters and power mixers with care. Do not touch their moving parts. Before turning on power, check to see that the wiring is in good repair. Do not forget to turn off the heaters after work.

Clean your overalls every day. After work, wash your hands with drying oil, kerosene, turpentine, warm soapy water, or special cleansing agents to remove dirt. Use warm water and soap to wash your face.

Open the door and windows to ventilate the room unless mechanical exhaust ventilation is provided.

Chapter Four

Tools, Fixtures, and Accessories

9. Glass Cutters

Glass is cut by scoring with a diamond or a steel wheel. Diamonds used for the purpose may be both natural and synthetic. Whatever their size, natural diamonds are given a rounded shape with 48 facets of which 24 facets can be employed for cutting glass. These include 12 longitudinal and 12 transverse facets, the former doing 90 to 95% of all cutting work. Depending on their origin, diamonds may be classed as hard and soft. The bort variety and also stones approaching bort in hardness are considered to be best suited for the job.

Glass cutters are fitted with diamonds 0.02 to 0.16 carat in mass (one carat being approximately equal to 0.2 g or 200 mg). The stones may be finished or unfinished. Both whole crystals of various shape and colour and fragments may be used. Of late, synthetic diamonds have been finding ever increasing application in glass cutting.

Diamonds 0.02 to 0.16 carat in mass (larger stones for heavy duty and smaller ones for light duty) can cut glass up to 10 mm thick, handling at least 10 000 m of flat glass before they need to be resharpened for the first time.

Soviet-made diamond tools are available in two types, namely type 1 tools with a four-facet pyramid (six modifications) and type 2 tools with a curved cutting edge (twelve modifications). The type and model of a diamond tool are indicated by numerals. For example, a type 1, model 1

diamond tool fitted with a 0.02- to 0.04-carat stone will be designated as 3890-0001. The leading particulars of Soviet-made diamond tools can be found in Tables 7 and 8.

Table 7. Type 1 Diamond Tools

Designation		Mass in carats	Glass thickness, mm
Model 1	Model 2		
3890-0001	3890-0002	0.02-0.04	Up to 3
3890-0003	3890-0004	0.05-0.10	4-5
3890-0005	3890-0006	0.11-0.16	6-10

Table 8. Type 2 Diamond Tools

Designation		Mass in carats	Glass thickness, mm
Model 1	Model 2		
3890-0011	3890-0012	0.02-0.04	Up to 3
3890-0013	3890-0014		
3890-0015	3890-0016	0.05-0.10	4-5
3890-0017	3890-0018		
3890-0019	3890-0022	0.11-0.16	6-10
3890-0021	3890-0024		

A *glazier's diamond* (as a glass cutter fitted with a diamond is usually referred to in the trade) is essentially a diamond tool fixed by a stop screw *6* in a hammer-shaped shaft *2* (Fig. 8). The hammer head (in this text, we shall call it the hammer for brevity) is made of steel or brass, and the handle is made of polystyrene or phenolic plastic. A slot *5* is provided on one side of the hammer to grip narrow strips of glass in breaking sheets along the cut. The diamond tool consists of a bit holder, which may be square (reference number *7* in the figure) or round (reference number *8*) in cross section, and a diamond crystal *1* fitted into the holder and bonded by a silver or any other suitable solder. Type 1 square diamond tools with a four-facet crystal have numer-

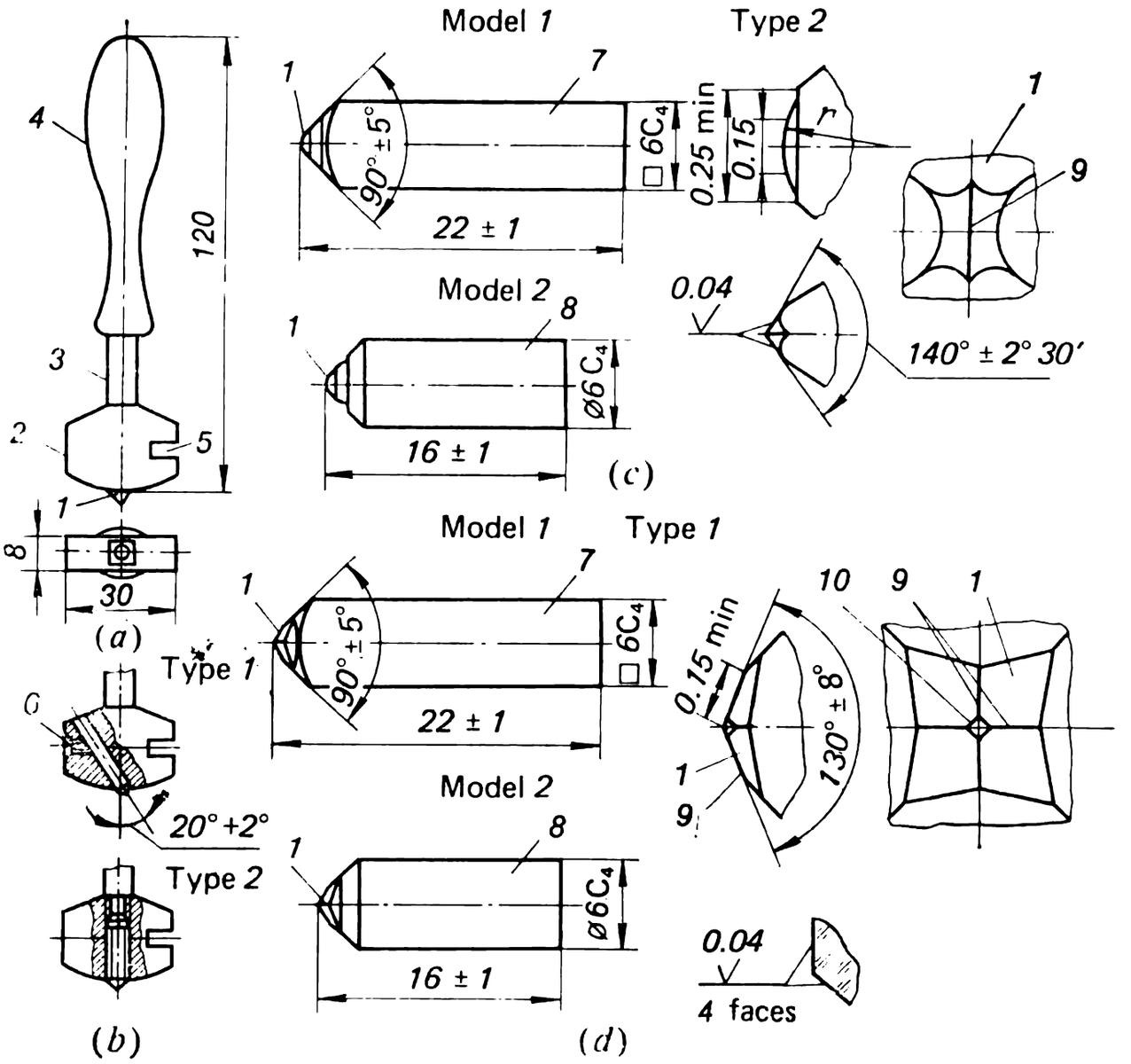


Fig. 8. Glazier's diamond

(*a*) general appearance; (*b*) fixing diamond tools in the hammer; (*c*) type 2 diamond tool with a curved cutting edge; (*d*) type 1 diamond tool with a four-facet pyramid (four cutting edges); (*1*) diamond; (*2*) hammer; (*3*) connecting sleeve; (*4*) handle; (*5*) slot; (*6*) stop screw; (*7*) square bit holder; (*8*) round bit holder; (*9*) cutting edges; (*10*) table (in four-facet diamond)

als (1, 2, 3, and 4) on their sides to indicate the cutting edges. This kind of tool is recommended for skilled workmen. Type 2 tools with a curved cutting edge *9* have no numerals. They are a good choice for beginners.

Tools with a square holder are fixed in position by a stop screw *6*, whereas round holders are held in place by a threaded sleeve *3*. Type 1 diamond tools with a four-facet pyramid and a square holder are set at 20 to 22° to the cutter's

axis. Curved-edge diamond tools are placed along the same axis with the cutter.

The cutting edges should be replaced as soon as they grow blunt. To change the cutting edge, loosen the stop screw, take the tool out of the hammer, turn it through 90°, fit it back into the hammer with the diamond point extending 1 to 3 mm from the seat, and tighten the stop screw. The cutting edge of the diamond (or the tool holder as a whole) and the side of the hammer in contact with the rule in cutting should be parallel to within 1°30′. The misalignment of the hammer, connecting sleeve, and handle of the cutter should not exceed 2 mm. To make up for the possible lack of parallelism and misalignment in cutting, the glazier's diamond is set slightly inclined relative to the glass as shown in Fig. 9.

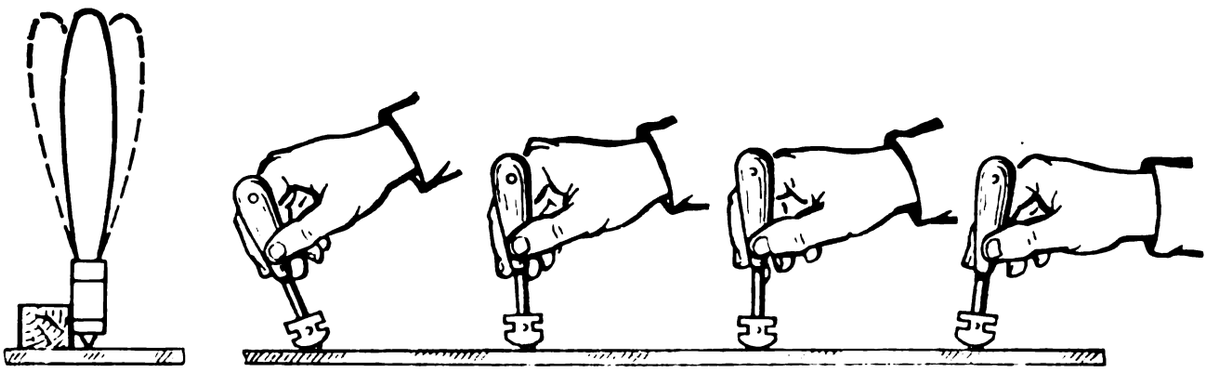


Fig. 9. Holding a glazier's diamond

Diamonds have to be resharpened from time to time as their cutting edges grow blunt. The angle of the cutting tip may vary from 130 to 138° for a four-facet crystal and from 138 to 142° for a curved-edge crystal. The stones are sharpened on a cast-iron wheel or a flat lap charged with an abrasive paste containing diamond dust. Sharpened like that, the diamond will not yet cut glass. Rather, it will slide over the surface, leaving untidy scratches sometimes. So, it is further dressed on a piece of glass until it can score the material again, producing an almost invisible mark instead of a white strip. Lapping and dressing leave a pointed tip on a four-facet crystal. The tip should be removed so that the four cutting edges *9* could be used. This leaves a miniature table *10* which can be seen in Fig. 8.

Some Soviet-made glass cutters may be fitted with two types of interchangeable diamond tools which can likewise cut glass sheets up to 10 mm thick, handling at least 10 000 m of glass before resharpening.

Glass cutters equipped with curved-edge synthetic diamonds can cut glass sheets up to 5 mm thick, turning out at least 12 000 m of glass before resharpening.

Wheel-type glass cutters may have one or several hard-alloy wheels. The three-wheel cutter of Fig. 10*a* is intended

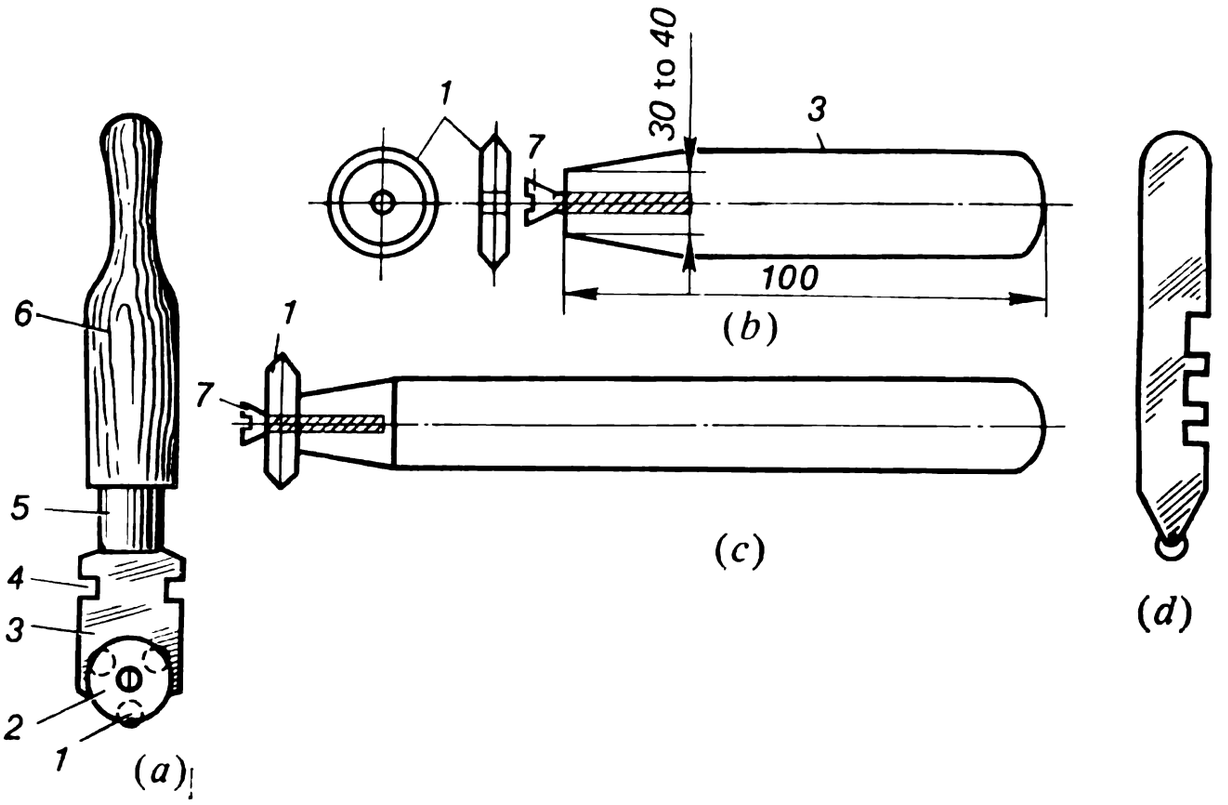


Fig. 10. Hard-alloy wheel-type glass cutter
(*a*) three-wheel cutter; (*b*) holder; (*c*) fixing a wheel in the holder; (*d*) home-made glass cutter; (*1*) wheel; (*2*) wheel holder; (*3*) head; (*4*) slot; (*5*) ferrule; (*6*) handle; (*7*) screw

for cutting glass sheets 1 to 4 mm thick. The wheels *1* are 6.6 ± 0.6 mm in diameter, have a cutting-edge angle of 100 ± 10°, and can handle at least 350 m of glass each. As they grow blunt, the wheels are used to cut thicker glass sheets. To replace the wheels, loosen the screw and turn the wheel holder *2* through 120°.

As they wear out in service, wheels leave a poorly recognizable score on the glass surface. In this situation, the sheets become difficult to break along the cut or they may break elsewhere, thereby adding to breakage. To cope

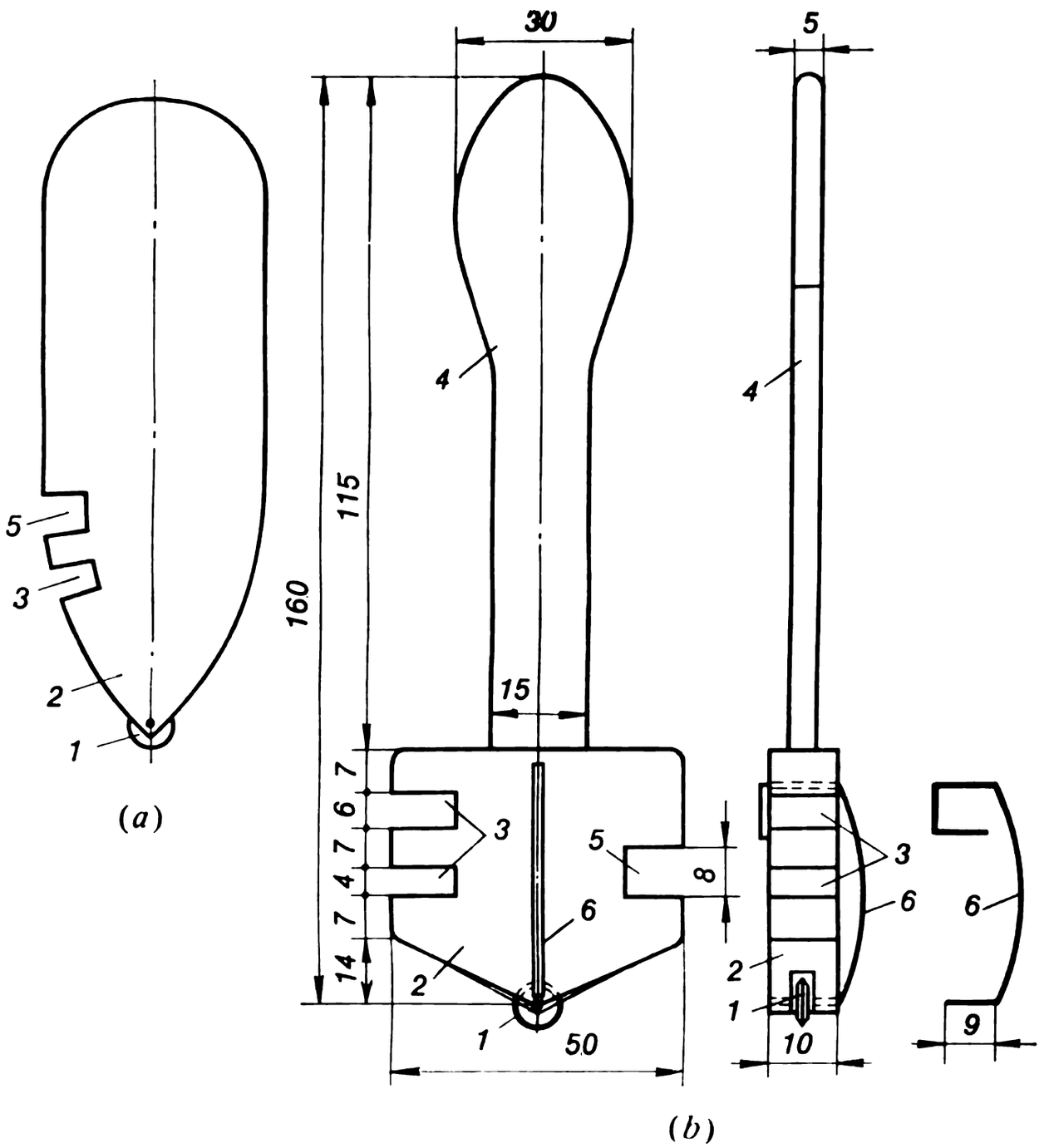


Fig. 11. Alternative glass cutters
(*1*) wheel; (*2*) head; (*3*, *5*) slots; (*4*) handle; (*6*) attachment spring

with the problem, the glass needs to be tapped with the blunt end of the cutter on the other side right opposite the cut until it cracks along the scribed mark.

Blunt wheels are sharpened on a hand- or power-driven fine-grain grinding wheel. In so doing, the wheel should be held in pliers or in a specially designed holder *3* (Fig. 10*b* and *c*). Where a holder is used for the job, the wheel to be ground is fastened at the conical end (3 to 4 mm in diameter)

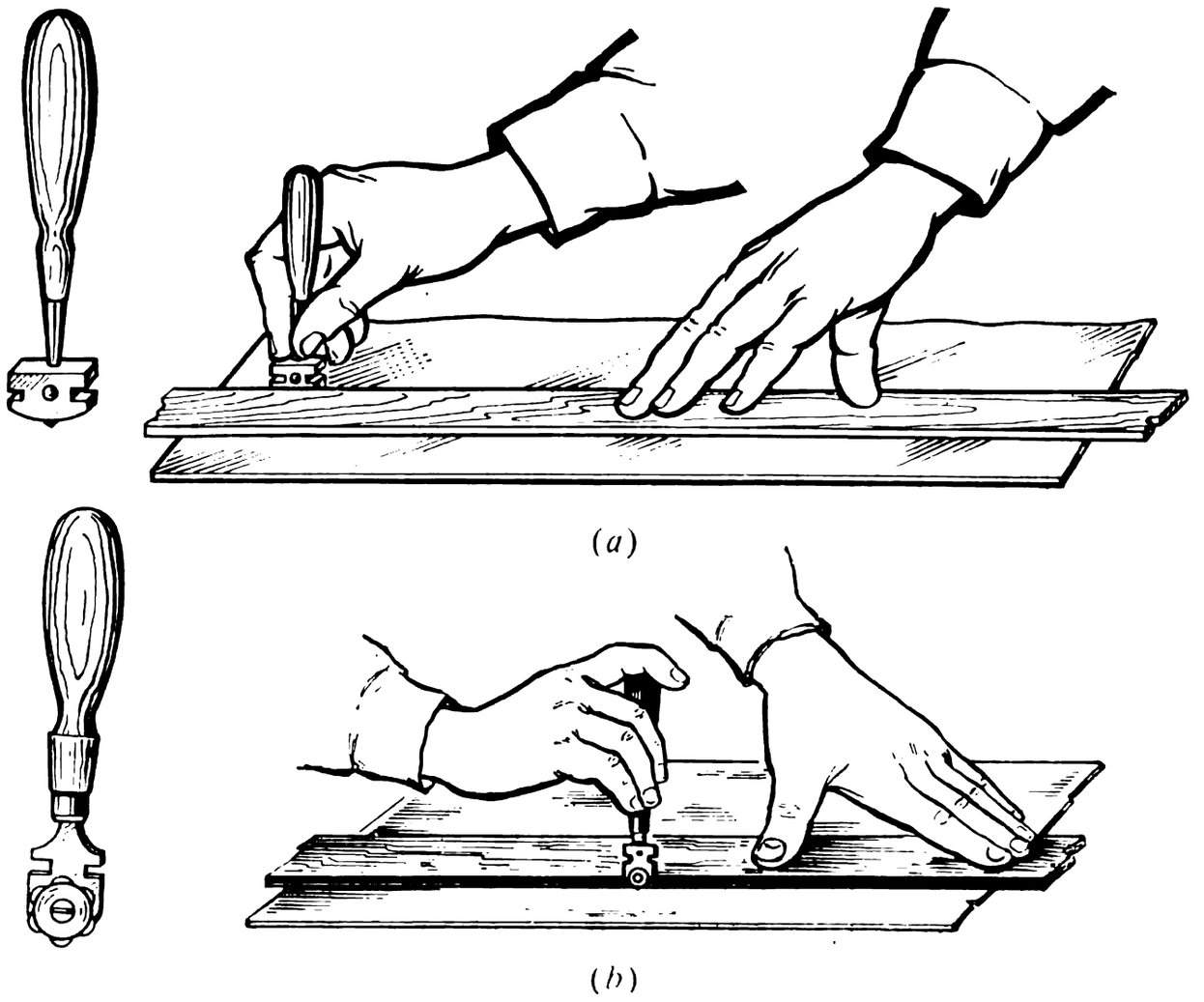


Fig. 12. Cutting flat glass with (*a*) a glazier's diamond and (*b*) a wheel-type cutter

with a screw 7 as shown in the figure. The wheel is ground on both sides at a desired angle.

Alternative wheel cutter types are shown in Fig. 11.

Manual cutting should be done using a straightedge or a template as shown in Fig. 12. The straightedge (or template for that matter) should be at least 8 or 10 mm thick to provide adequate support for the cutter. If they are allowed to wobble, glass cutters will become unfit for service very soon.

To cut a sheet of glass, grasp the glazier's diamond with the thumb and forefinger close to the hammer. Place the cutter on the glass so that it touches the straightedge and pull it along, exerting light pressure on the diamond as if you were handling a pencil. Find the necessary angle by making trial cuts. If it is set and pressed correctly, the diamond will leave a narrow, clean and almost invisible cut.

As it scores the glass, the diamond should make a crackling sound which will tell that the glass is scratched to a very small depth (a fraction of a millimetre). This pin-stripe mark can only be seen through a magnifying glass on the plane of fracture after the sheet has been broken. A wide scratch and whitish glass dust are an indication that the tool setting is wrong or that too much pressure is exerted on the diamond. More pressure should be applied as the cutting edge grows blunt. Ease off the pressure within 3 to 5 mm of the end of the cut to prevent the diamond from going off the glass and getting damaged against the sheet edge or the hard surface of the table. Do not cut along the same line twice or score wet or dirty glass. Keep the diamond in a sheath when not in use to protect the cutting edge against rough handling.

Where the job is done with a wheel-type cutter, hold the cutter at right angles to the glass surface with your thumb and middle finger or with the thumb, middle finger and fourth finger, exerting pressure with the forefinger as shown in Fig. 12*b*. As it is pulled along the straightedge, the wheel cutter leaves a white scratch. As a rule, the glass sheet is broken over the edge of the bench or table. If the glass refuses to break, tap it lightly with the blunt end of the cutter on the other side right opposite the cut until it cracks along the scribed mark. Then break off the unnecessary parts over the bench edge (if they are large) or do this with a toothed plate (if they are small).

10. Electric Glass Cutters

A simple *electric glass cutter* is shown in Fig. 13. It incorporates a wooden table *1* with slots *5* cut in its top. The slots serve as guides for a movable straightedge *7* which can be fixed in position by screws and butterfly nuts *6*. A sheet of asbestos-cement *4* is placed at one end of the table to give support to a heating element *9* of Nichrome, Nickeline, or similar wire 1 to 1.25 mm in diameter, which can heat up in 5 to 6 seconds. The wire is fixed to a roller at one end and passed over a block *3* at the other end. It is pulled taut by a weight *2* attached at its free end. The heating element is connected by wires *10* to a transformer *11*. The

weight and the heating wire diameter are selected by trial.

A *type ERS-1 factory-made electric cutter* is shown in Fig. 14. It consists of a metal frame with a steel-sheet top, an asbestos-cement plate, and a template to lay out glass sheets for cutting. The table may be 1 250 to 1 800 mm long, 600 to 900 mm wide, and 780 mm high. The heating element is made of Nichrome wire laid in a coil-like fashion.

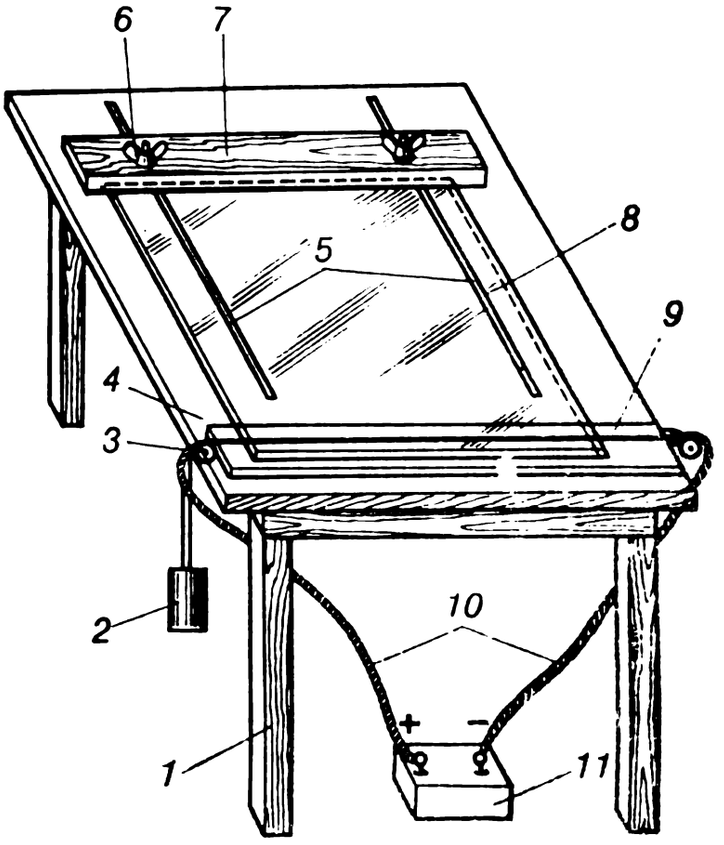


Fig. 13. Electric glass cutter

(*1*) wooden table; (*2*) weight; (*3*) block; (*4*) asbestos-cement sheet; (*5*) slots; (*6*) butterfly nut; (*7*) movable straightedge; (*8*) glass; (*9*) Nichrome wire; (*10*) electric wires; (*11*) transformer

For its operation, the unit depends on the same principle as the electric cutter described previously. The per hour capacity of the type ERS-1 electric cutter is about 300 cuts with 2-mm sheets, 120 cuts with 2.5- to 4-mm sheets, 65 cuts with 4- to 6-mm sheets, 69 cuts with figured glass up to 5 mm thick, and 62 cuts with wire glass.

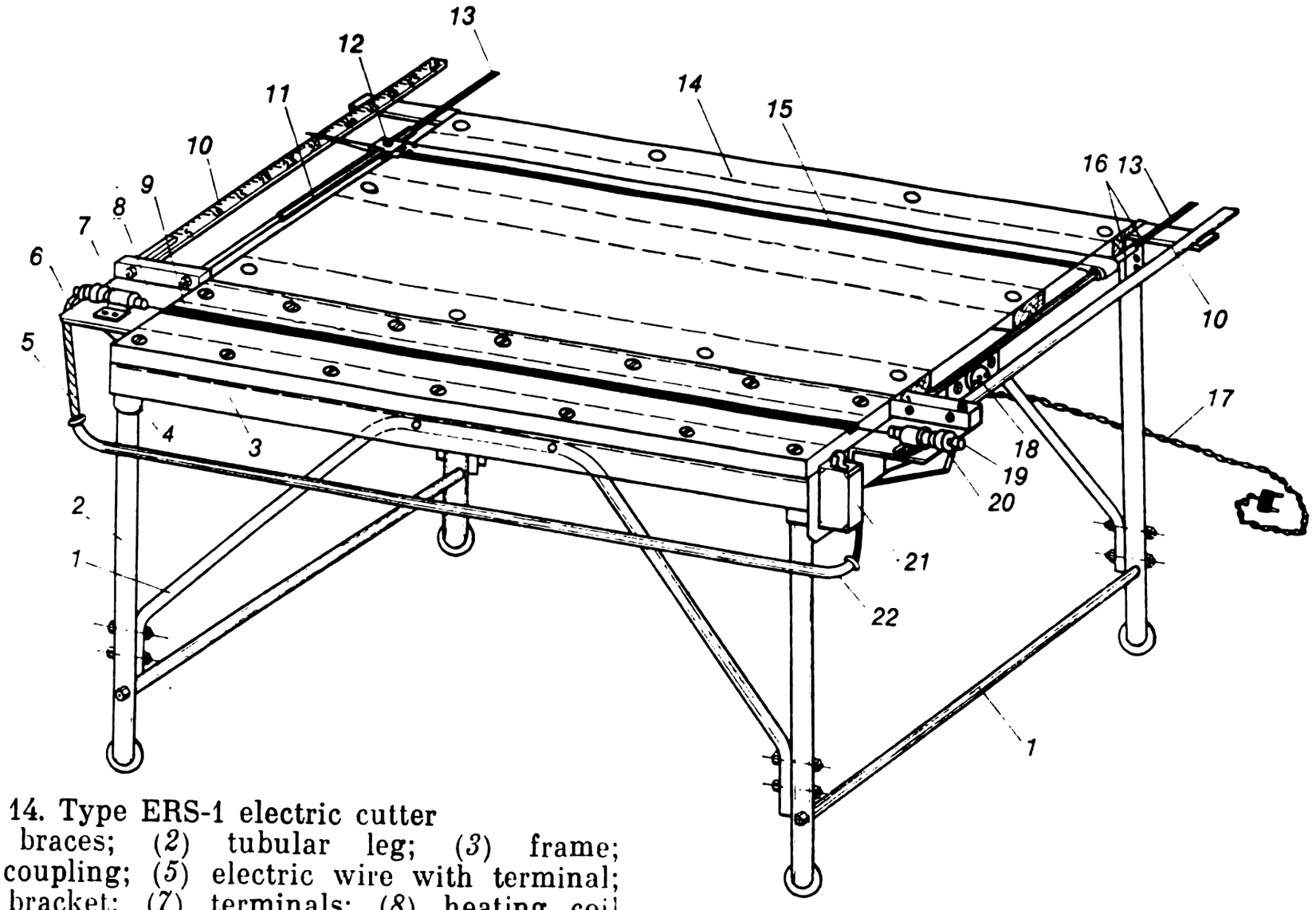


Fig. 14. Type ERS-1 electric cutter
(*1*) braces; (*2*) tubular leg; (*3*) frame; (*4*) coupling; (*5*) electric wire with terminal; (*6*) bracket; (*7*) terminals; (*8*) heating coil of Nichrome wire; (*9*) asbestos-cement plate; (*10*) rules; (*11*) guide tubes; (*12*) butterfly nut; (*13*) guide rods; (*14*) metal base; (*15*) stop straightedge; (*16*) straightedge bracket; (*17*) power cord; (*18*) socket; (*19*) screw and nut; (*20*) ceramic insulators; (*21*) switch; (*22*) electric-wire conduit

11. Other Tools, Fixtures, and Accessories

In addition to glass cutters, the glazier may need a variety of other tools, fixtures, and accessories (Fig. 15) whose brief description follows.

Straightedges *1* are pieces of planed, seasoned softwood of various length, with parallel and straight edges (hence their name), with or without divisions, 30 to 40 mm wide, and 5 to 10 mm thick. They are used to measure glass and serve as guides for glass cutters.

Squares or try squares *2* are L-shaped wooden tools for setting out right angles. They may also serve as guides for glass cutters.

Folding rules *3* are wooden or metal pocket rules divided into centimetres. They are employed to measure and lay out glass sheets for cutting.

Tray *4* is a wooden or metal (roofing-steel or tin) vessel in which putty, glazing compounds, and mastics are prepared and stored.

Hacking and putty knives *5* and *6* of various shape and size are used to mix, to apply, and to smooth out glazier's putty, glazing compounds, and mastics. Some types may have their ends cut at 60 to 70° and their edges blunted. Wooden knives are also available.

Screwdrivers *7* with blades of various width are used in fixing glass panes with glazing beads and moulds.

Hammer *8* is necessary to drive nails and to open boxes containing glass sheets.

Brace *9* and hand drill *10* are used for drilling holes.

Drills *11* are used for making holes in glass. They are made of pieces of old files of various shape and size or hard steel. Their ends have three or four sides and a pointed tip.

Honing sticks *12* of various shape and size are employed to round the sharp edges of glass panes and to give a final, long-lasting polished edge to cutting tools.

Toothed plate *13* has slots of various depth and width to break off narrow strips of glass.

Templates *14* are needed to measure glass and to give support to glass cutters.

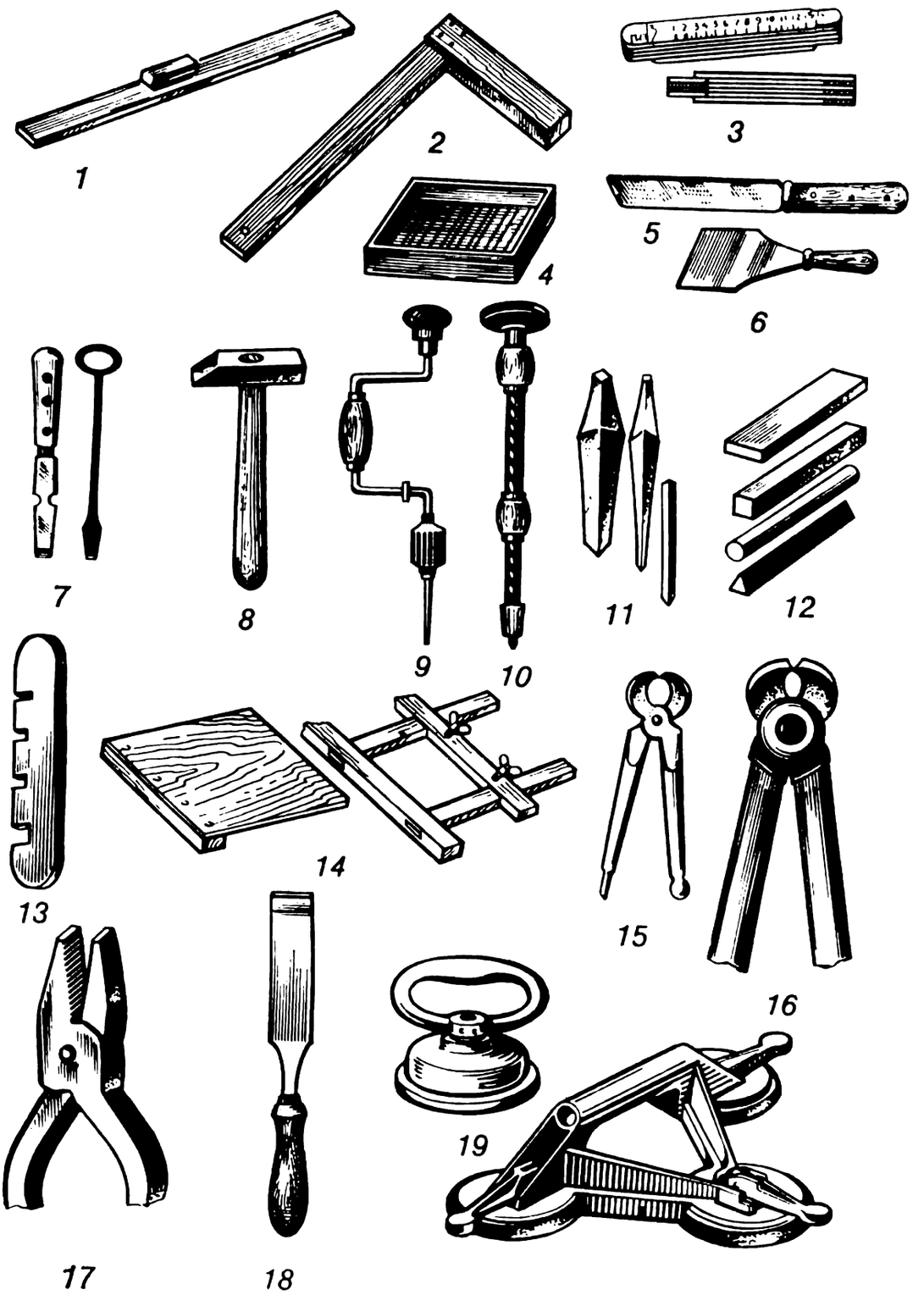


Fig. 15. Glazier's tools and accessories

(*1*) straightedge; (*2*) try square; (*3*) folding rule; (*4*) tray; (*5*) hacking knife; (*6*) putty knife; (*7*) screwdrivers; (*8*) hammer; (*9*) brace; (*10*) hand drill; (*11*) drills; (*12*) honing sticks; (*13*) toothed plate; (*14*) templates; (*15*) tongs; (*16*) nippers; (*17*) pliers; (*18*) wood chisel; (*19*) suckers

Tongs *15*, nippers *16*, and pliers *17* are employed to extract nails, to cut wire, and to break off glass edges.

Wood chisels *18* are used to drive staples and sprigs, to remove old putty from rabbets, etc.

One-, two-, and three-cup suckers *19* differing in load capacity can conveniently be used to pick up and carry large plates of glass.

Staplers and nailers of various design serve to drive staples and nails into wooden rails, stiles, and muntins when securing glass panes to the sash.

The glazier should also have a plumb line with a string at least 10 m long (it is needed to check the lights of glass for vertical position and to lay out glass sheets for cutting), a rubber-cord placer, and a claw bar to open boxes containing glass sheets.

Tables and benches on which glass is laid out, cut, and fitted into the sash are usually made of wood. Their tops should be covered with two layers of felt, broadcloth, or any other thick cloth to prevent the glass from breaking. The average height of the tables and benches is 760 mm. Portable knock-down types can easily be moved from place to place and are very convenient in storage.

Chapter Five

Scaffolds, Ladders, and Cradles

12. Scaffolds

As a rule, glass is fitted into the sash on the ground in appropriate workshops. In some situations, however (say, where the sash are too heavy to be lifted by hand), this has to be done directly in the opening, often high above the ground. If so, scaffolding is needed to support the workmen and materials.

Scaffolds are many and varying, so their detailed description would be too formidable a task for a book of limited volume. Apart from stationary scaffolds (tubular

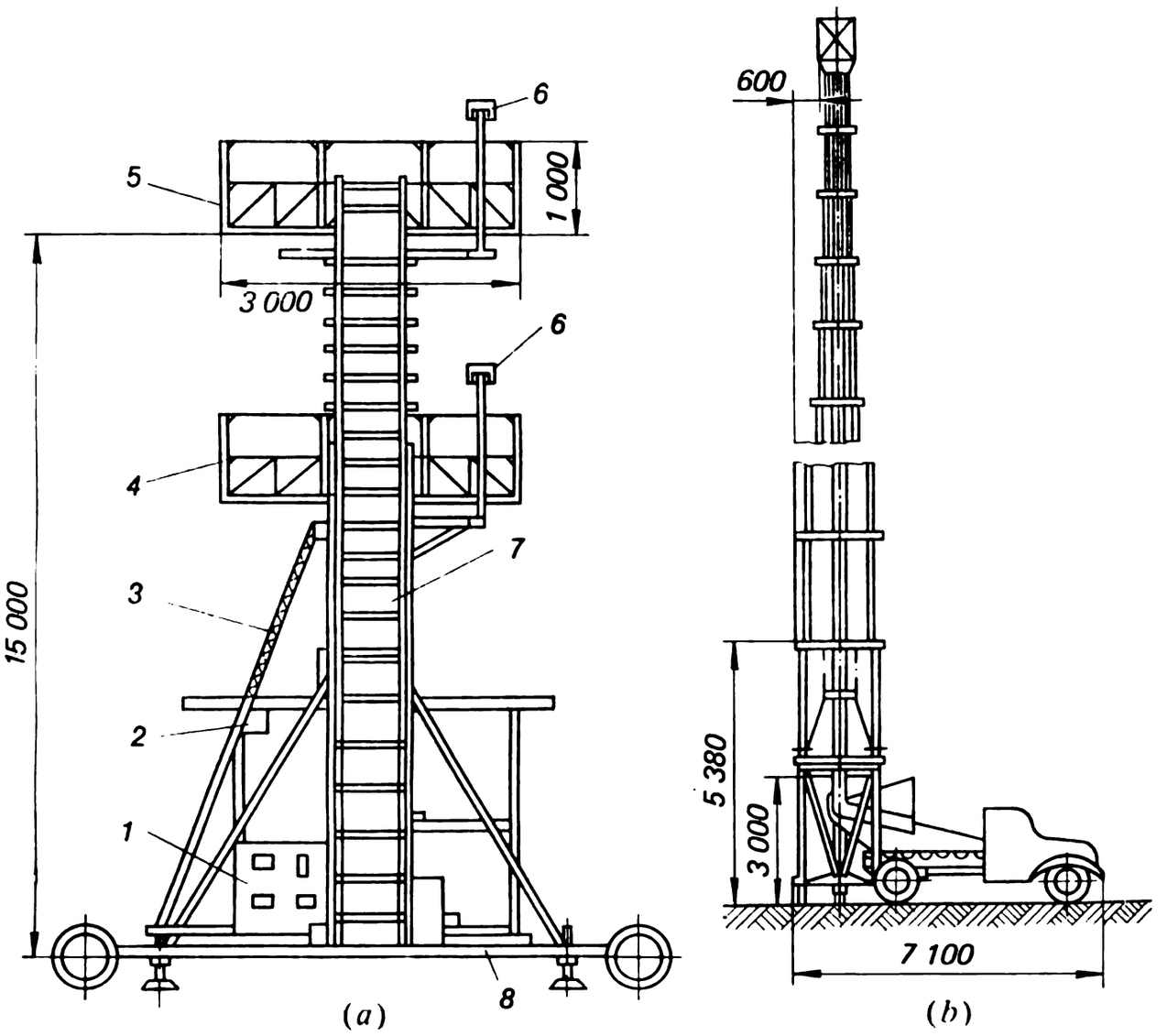


Fig. 16. (*a*) Rubber-tyred telescopic mast, (*b*) truck-mounted telescopic mast
(*1*) electric equipment; (*2*) hoisting winch; (*3*) jack; (*4*) middle platform; (*5*) top platform; (*6*) derrick; (*7*) telescopic shaft; (*8*) carriage

scaffolding, bricklayer's scaffolds, mason's scaffolds, etc.) which are very popular with builders and are described elsewhere, use is widely made of movable types which may be self-propelled or pushed from place to place by the workmen. The *rubber-tyred telescopic-mast scaffold* of Fig. 16*a* can reach within 15 m of the ground and has two platforms, which is very convenient in setting large plates of glass. The *truck-mounted telescopic-mast scaffold* of Fig. 16*b* has only one platform, but it offers a better manoeuvrability and can reach within 32.5 m of the ground. Mast scaffolds are generally used for repair jobs. Sometimes, a suspended scaffold may come in handy.

A projecting scaffold, which is essentially a working platform built out from a window opening, is only required where fanlights or outswinging casements are to be glazed or repaired. The platform should be made narrower than the opening, and the casement being glazed should be kept closed.

Appropriate scaffolds are also needed when working on low openings both indoors and outdoors. These may be temporary trestled structures (scaffold board supported on four-legged ladders) or solid, braced constructions composed of scaffold boards laid on standards (poles). It is strictly prohibited to work from makeshift supports, such as boxes, barrels, upturned buckets, and the like.

13. Ladders and Cradles

Ladders are used in doing a host of jobs in building practice, and glazing is no exception. They are strong, light, can easily be moved from place to place, and are particularly convenient when equipped with working platforms.

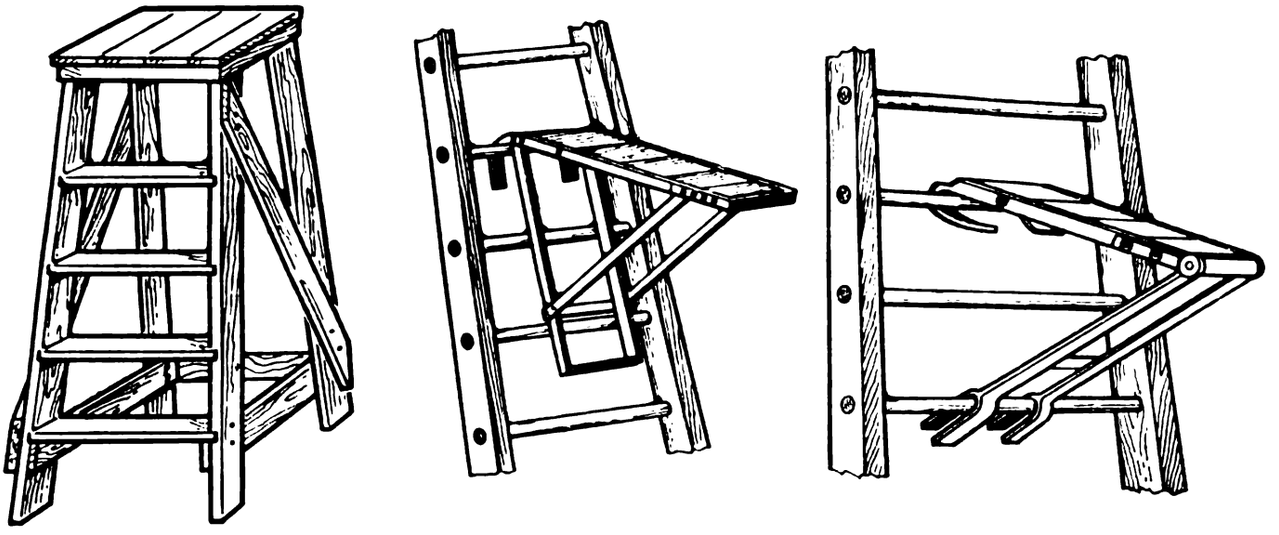
Ladders consist of two long wooden stiles spaced apart by rungs (or treads in the case of step ladders) wedged tightly into holes mortised in the stiles at 20 to 30 cm centres. Light-alloy (say, duralumin) ladders are much lighter than wood ladders. Different types are the builder's ladder, standing ladder, extending ladder, step ladder, and steps. The last-mentioned type, also known as the pair of steps, is a step ladder with a framed stay hinged to the top so as to make it self-supporting. The rungs or treads are additionally tightened by bolts at 2-m intervals. Ladders up to 3 m high should be at least 0.5 wide at the bottom. In higher ladders, the distance between the bottoms of the stiles should be increased. The ends of the stiles are usually equipped with metal spikes or rubber shoes to prevent them from slipping.

As mentioned earlier, working platforms may be placed on the rungs as shown in Fig. 17*b* to prove extra room for workmen and tools. The platforms have a frame of steel angles, on which wooden boards are laid.

Light work can be done from what is known as a ladder scaffold—a scaffold quickly erected on ladders braced together.

Platform ladders (Fig. 17*a*) also find application in glazing practice. They are sufficiently wide to house tools and materials. Scaffold boards placed on two such platforms make a good supporting structure, too.

Cradles or *boat scaffolds*, as they are sometimes referred to, are removable scaffolds hanging on ropes. They may take up one or more workmen when glazing windows in tall buildings, but should generally be avoided where other



(*a*) (*b*)

Fig. 17. (*a*) Platform ladder, (*b*) ladders with working platforms

means of scaffolding are available. Before work, cradles must be tested under a static load which should exceed the design value by at least 25%. It is strictly forbidden to overload the cradles. Care must also be taken to inspect the cradles, ropes, rope attachments, brakes, and brackets before work. All defects (if any) must be rectified immediately. The same applies to scaffolds.

A word of caution is necessary in conclusion. Never work on cradles or scaffolds on rainy days, during thunderstorms, or in heavy wind. Be sure to remove all materials when the shift is over. Do not store open glass boxes under the scaffold platforms. Replace the lids or put the boxes indoors after work.

Chapter Six

Cutting Flat Glass

14. Precutting Procedure

Glass should be cut in a suitable workshop equipped with tables, workbenches, and racks. Boxes of glass should be brought in at least one day before cutting. Glass stored out of doors in winter should be allowed to warm up until the condensed moisture dries out completely.

The glass boxes should be put in an upright position and leaned upon a firm support (a wall, a partition, or a pier) in a specially assigned place.

The boxes should be opened with care. Wood chips and boards should be removed from the workshop immediately.

Never cut dirty, wet, or oily sheets. Dirty glass cannot be cut to the desired depth and will not break off straight along the cut (in fact, it may break off anywhere else). In view of this, take care to wipe off dirt, moisture, and oil from both sides of the sheet.

15. Laying Out, Cutting, and Breaking

An optimum layout is critical as far as the cost of work and the amount of wastes are concerned. A great number of undersize remnants unfit for use are a direct result of a poor layout.

Let us discuss the laying-out procedure by way of example. Suppose we are required to cut panes of glass measuring 500 × 300 mm out of a sheet 1 200 × 600 mm large. With an optimum layout (Fig. 18*a*), we shall get four panes of desired size and a remnant 200 mm wide and 600 mm long. In this case, the total length of the cuts will be equal to 2 200 mm (2.2 m). With a poor layout (Fig. 18*b*), we shall likewise obtain four panes, but the remnant will be 100 mm wide and 1 200 mm long. Here, the total length of the cuts will run into 2 700 mm (2.7 m).

Now, let it be required to cut panes measuring 700 × 300 mm out of a glass sheet 1 200 × 800 mm in size.

This job can be tackled differently, depending on how the remnant will be cut further. For example, we may obtain three panes of the desired size and two smaller pieces 200 mm wide, or two 700 × 300 mm panes, one 800 × 500 mm pane, and a remnant 200 mm wide.

When placed in position, a pane of glass should cover

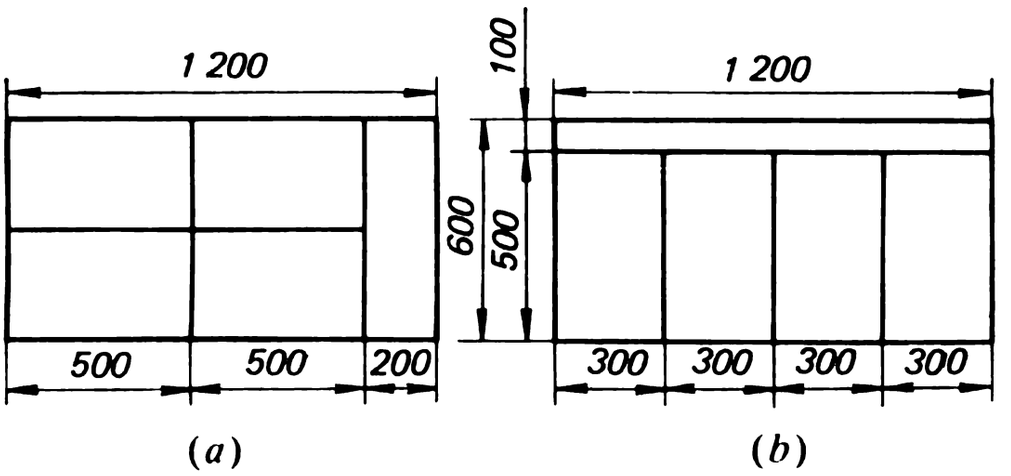


Fig. 18. (*a*) Optimum layout, (*b*) poor layout

three-fourths of the rabbets. The gap between the edges of the glass and rabbets should not exceed 2 mm. To demonstrate, where the distance between the rails is 1 000 mm and that between the stiles is 700 mm, the glass should be 995 to 997 mm long and 695 to 697 mm wide (Fig. 19).

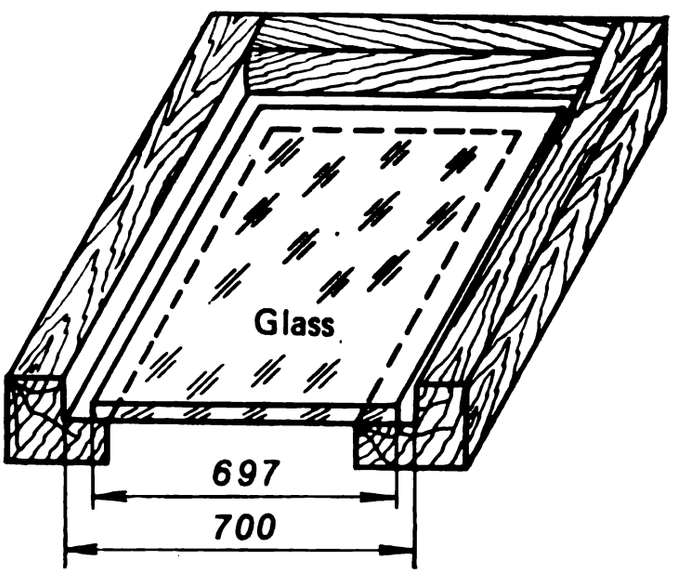


Fig. 19. Glass pane dimensions

The spaces between the edges of the glass and rabbets are left to facilitate the placement of the pane and to prevent the glass from undue pressure exerted by the swollen stiles and rails should they get wet.

After a notch has been cut, the glass is broken by folding it, as it were, in the opposite direction. If the cut is sufficiently deep, the glass will not resist breaking. To deepen the cut, it is advisable to tap the glass with the blunt end of the cutter on the back side opposite the cut. After that, the glass will break easily.

More often than not, flat glass is broken over the edge of the bench or table. For this purpose, move the sheet to the edge until the cut and the edge coincide. Press down the sheet with one hand, grip the overhanging end with the other, and bend the glass over along the cut.

If the cutter is sharp and makes a deep cut, it will suffice to lift up the glass slightly by the ends on either side of the cut.

As an alternative, the glass may be broken over a straightedge 5 mm upwards in thickness, which is laid under the sheet right along the cut. In this case, press down the overhanging end with one hand, holding the sheet in position with the other.

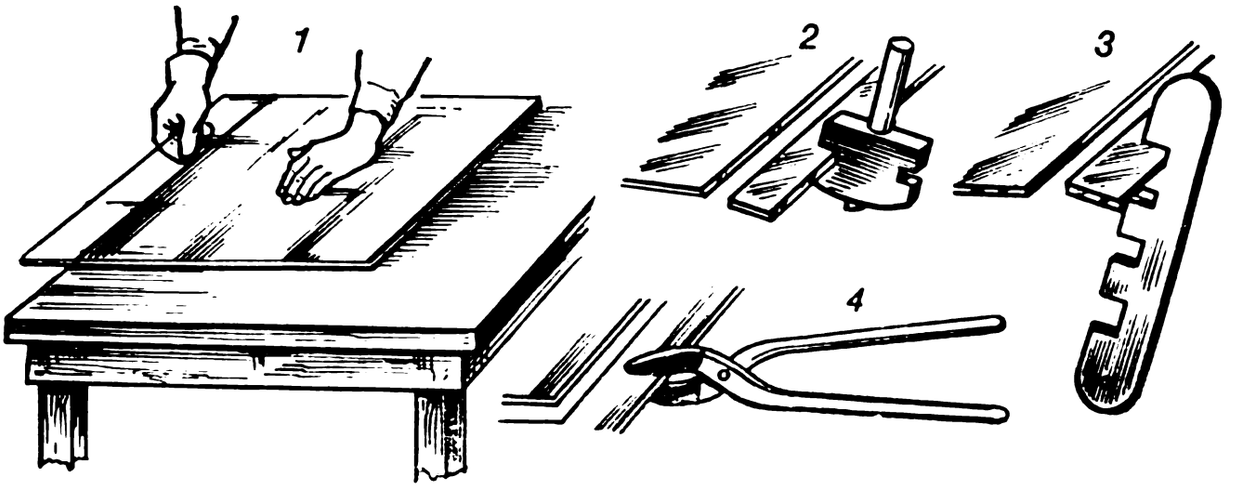


Fig. 20. Breaking glass
(*1*) by hand; (*2*) using the cutter; (*3*) with a toothed plate; (*4*) with pliers

Narrow strips of glass can be broken off by hand (Fig. 20, *1*) using the slots in the cutter's head (*2*) or a toothed plate (*3*), or with pliers (*4*). Where pliers are chosen for the job, put short lengths of rubber tube on the jaws or wrap the jaws up in a piece of cloth.

16. Cutting to Patterns and Templates

For small jobs (two or three sheets), glass may be cut directly *on the sash*. To this end, place the sheet on the sash and make a cut along the edge of one of the rabbets. Break off the unnecessary strip, reverse the sheet, make another cut, and break off the glass along the score.

In cutting glass *to patterns* (Fig. 21), draw the desired design directly on the table. You may also do it on a sheet of plywood, in which case you will have to fix the sheet firmly to the table top. Place a sheet of glass *2* on the drawing *1* so that its edges and the sides of the drawing coincide. Cut off the larger pane of glass, align the sheet again, and make a second cut to obtain the desired panes.

Templates can be made of plywood, fibre board, thick cardboard, etc.

A template (Fig. 22) is essentially a sheet of plywood or any other suitable material, *2*, with a stop bar of wood, *1*, nailed from beneath to serve as a rest. The position of the stop can be varied depending on the size of panes to be cut. The working edge *3*, which will be in contact with the glass cutter in operation, should have a smoothly planed surface. A planed batten 5 to 10 mm thick and 20 to 40 mm wide should preferably be nailed over the edge for better smoothness.

Let it be required to cut glass panes 900 × 550 mm large out of sheets measuring 1 500 × 1 000 mm. For this purpose, make two templates: one to cut off strips 100 mm wide and the other to cut the desired panes.

To begin with, cut off the 100-mm strips and arrange the trimmed sheets in a stack (10 to 15 sheets per stack). Then, use the larger template to cut the trimmed sheets to size. For this purpose, place the template over the stack, score the surface of the top sheet with a glass cutter, move the sheet to the edge of the stack until the cut is in line with the edge, and break the glass along the cut. Put the pane thus obtained on a rack and cut the next sheet. Put remnants in a table drawer.

An *adjustable template* (Fig. 23) has four components: a working batten (a straightedge), a stop batten *1*, and two measuring rules *2*. The cross section of the components is

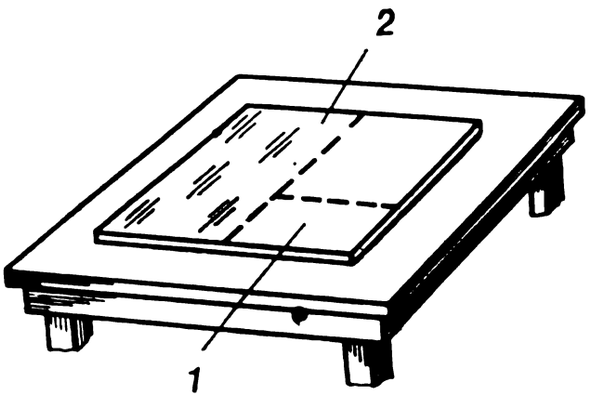


Fig. 21. Cutting glass to a drawing
(*1*) drawing; (*2*) glass (the cuts are shown by the dashed lines)

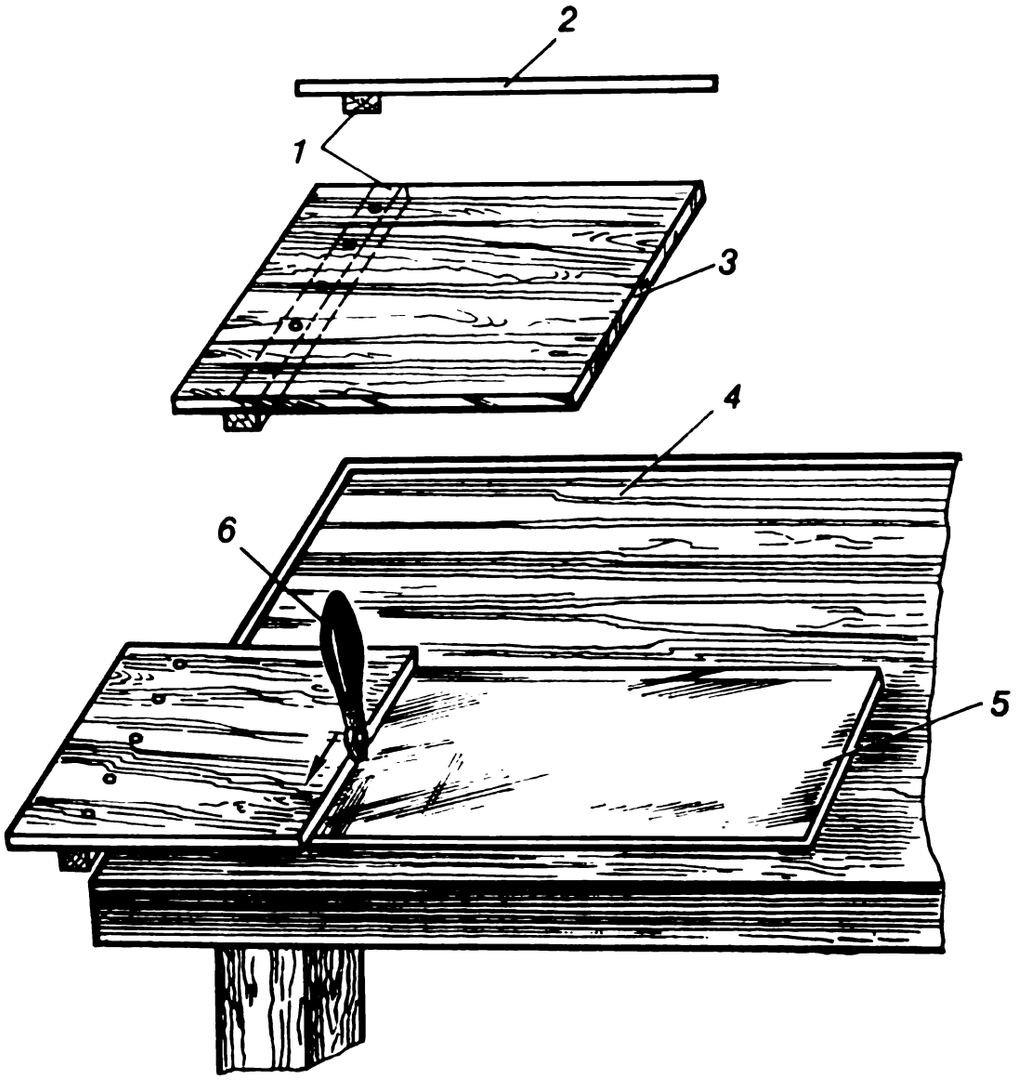


Fig. 22. Cutting glass to a template of plywood
(*1*) stop bar; (*2*) plywood; (*3*) working edge; (*4*) table; (*5*) glass; (*6*) glass cutter

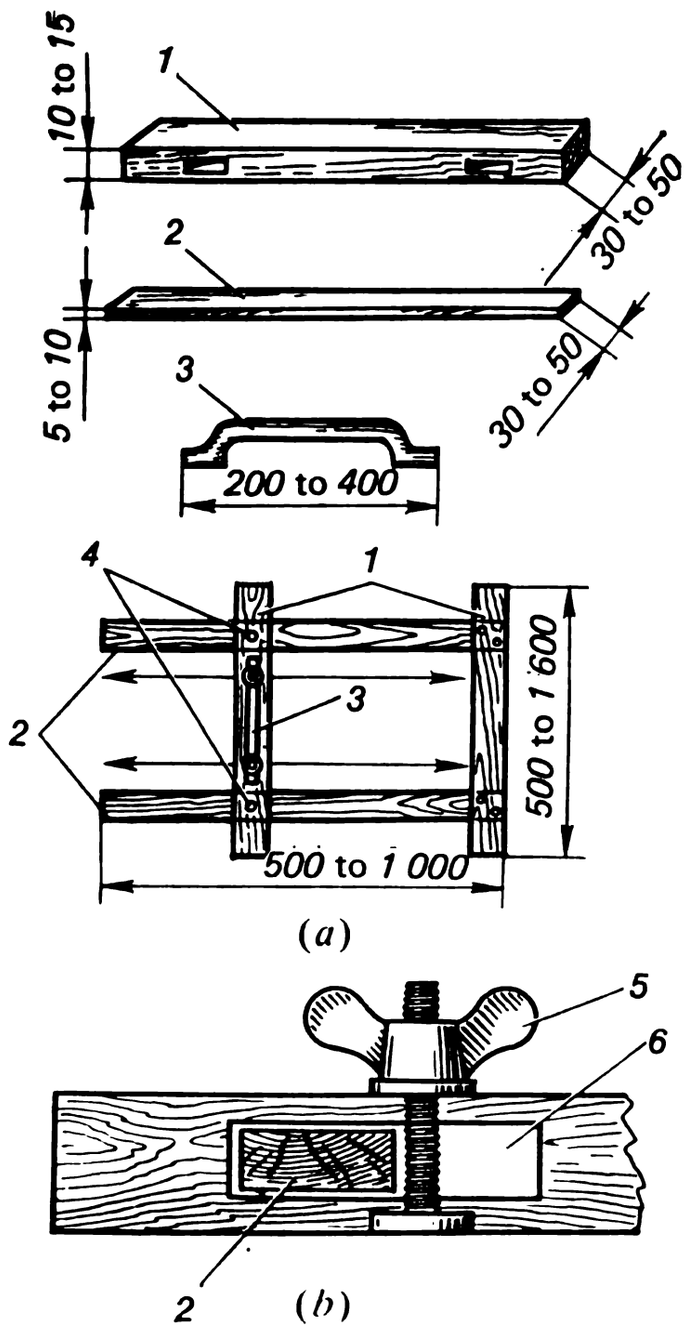


Fig. 23. Adjustable template

(*a*) general appearance and component parts; (*b*) screw and butterfly nut in the stop batten; (*1*) stop batten or straightedge; (*2*) measuring rules; (*3*) handle; (*4*) nails; (*5*) screw and butterfly nut; (*6*) hole for measuring rule

30 × 10 mm for smaller templates and 40 × 10 mm for larger templates. The straightedge and the stop batten have through holes cut within 200 mm of their ends, which should be large enough to allow free passage of the measuring rules. A handle *3* is attached to the stop batten for convenience. To assemble the template, insert the measuring rules into the holes in the straightedge so that they come 2 or 3 mm

short of the working edge. Tack the rules to the straightedge with nails. Put the stop batten on the measuring rules so that it is free to slide along them. Adjust the measuring rules for position and fix them to the straightedge with nails *4* as shown in the figure.

Adjust the template for size by moving the stop batten along the rules and fix the stop in position. It will be more convenient to use butterfly nuts *5* instead of the nails, in which case the holes in the stop batten should be enlarged to twice the original size to allow the wood to sag and hold the rules in place when the nut is tightened. The screws used in conjunction with the butterfly nuts should touch the measuring rules on one side.

Lay off the desired length or width of the pane to be cut (subtracting half the cutter's width) along the rules, using the working edge as a datum, scribe marks on the rules, and fix the stop batten to the measuring rules with nails or butterfly nuts *3* according to the marks (Fig. 24). Put

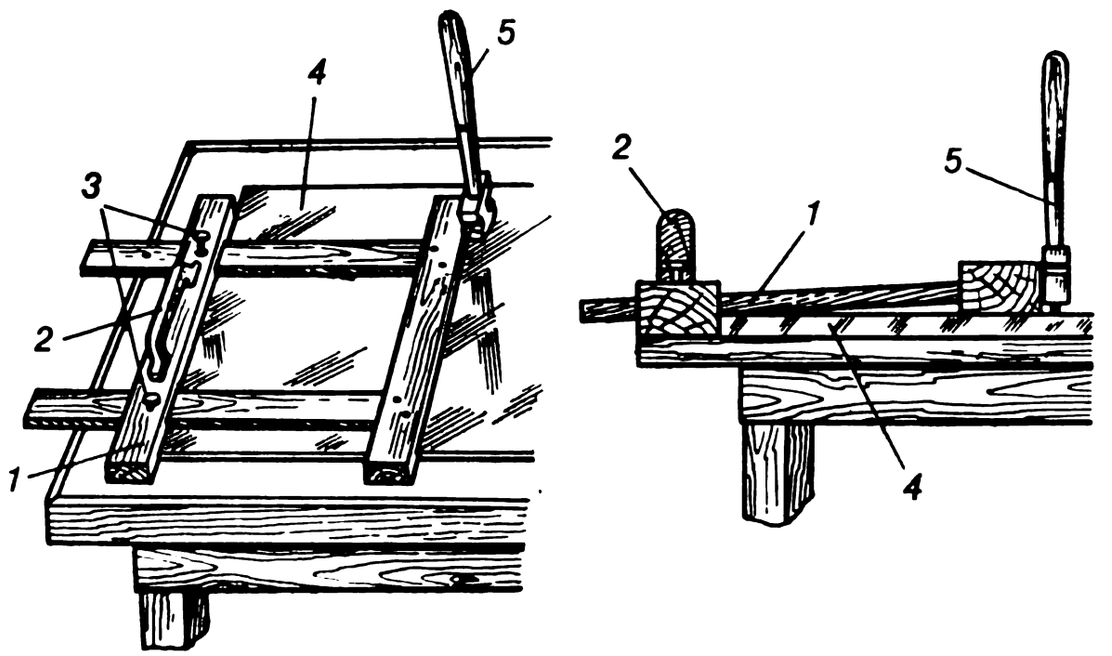


Fig. 24. Cutting glass to an adjustable template
(*1*) stop batten; (*2*) handle; (*3*) nails or butterfly nuts; (*4*) glass; (*5*) glass cutter

a sheet of glass on the table, take the template by the handle *2* with your left hand (if you are a right-hander), and place it over the glass *4* so that the stop batten *1* rests against the glass edge and does not allow the template to come off the

sheet. Take the glass cutter *5* with your right hand, set it against the straightedge, press it lightly to the glass, and make a cut. Then, take the template off, place the glass sheet with the cut over the edge of the table, and break off the pane. If the glass refuses to break, tap it lightly on the other side with the cutter.

17. Cutting Against Rules and T-Squares

Ordinary rules are a poor choice for cutting glass, since the pane dimensions have to be laid off every time a cut is made. Instead, use is made of specially designed rules some of which are discussed in the paragraphs that follow.

In using the rule of Fig. 25 (which may be both with

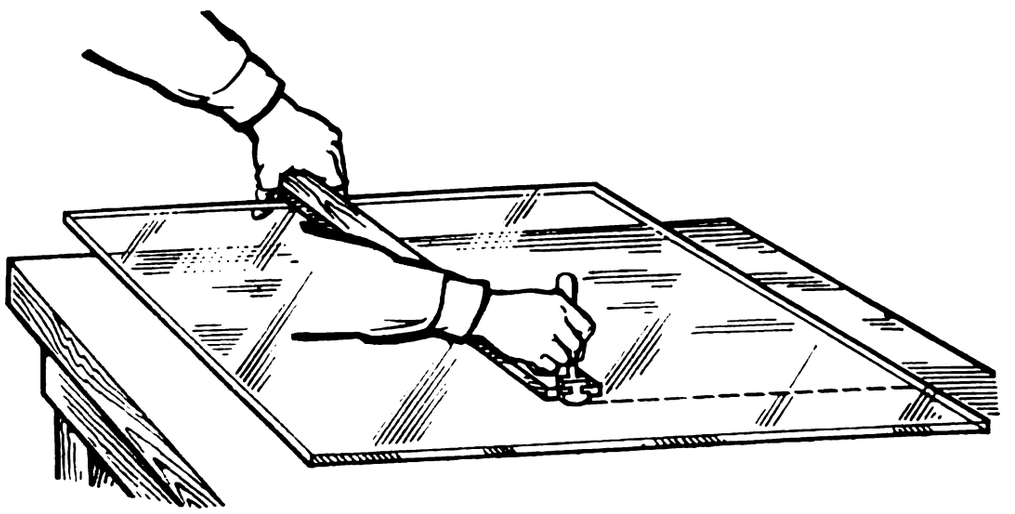


Fig. 25. Cutting glass with the help of a rule

and without divisions), lay off the desired dimension along the rule, subtracting half the cutter's width. Place the rule on a sheet of glass as shown in the figure, with your forefinger and thumb resting against the sheet edge. Set the glass cutter against the rule's end and pull it along the glass together with the rule. To avoid cutting your fingers, wear finger caps of leather or cloth.

Figure 26 shows a *T-square with an adjustable head.* The head consists of two wooden bars 10 mm thick each. In some constructions, one of the bars may be 15 mm thick and the other, 5 mm thick. A mortise is cut in the bars (or in the thicker bar as the case may be), whose width should be equal to that of the rule and whose depth should be by

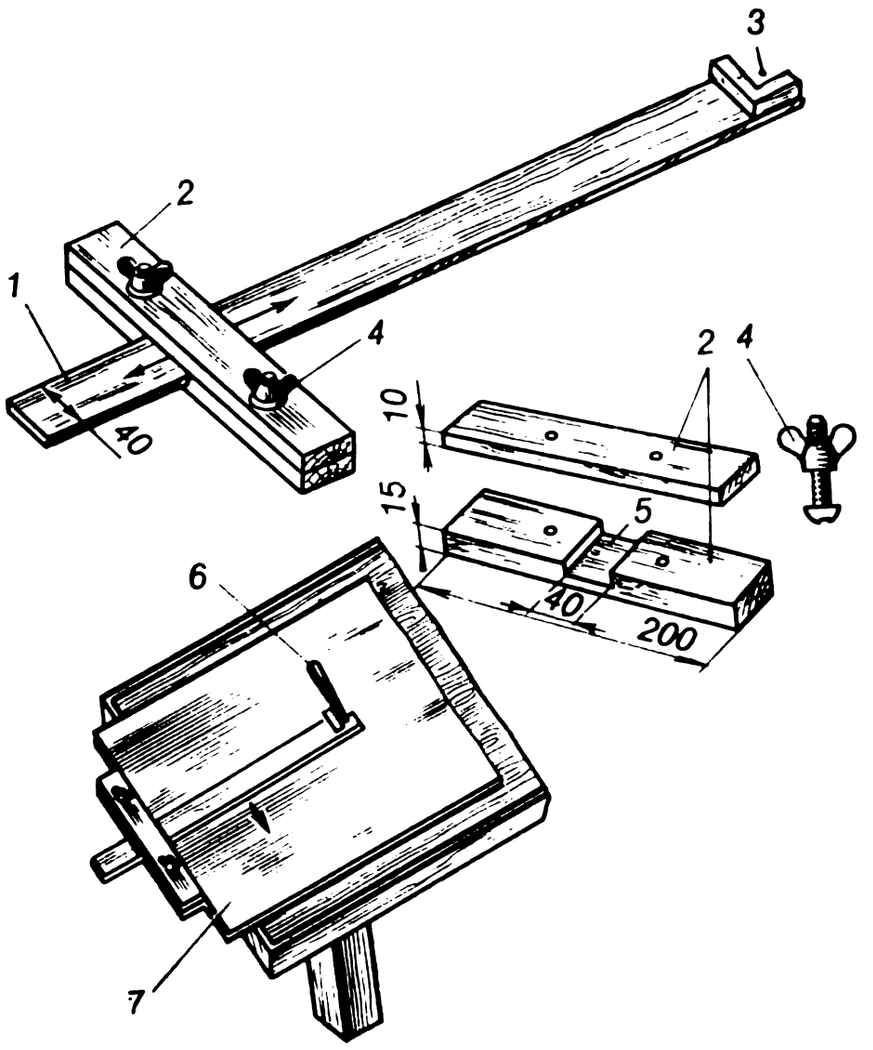


Fig. 26. T-square with an adjustable head
(*1*) rule; (*2*) head; (*3*) notch for glass cutter; (*4*) butterfly nut; (*5*) mortise; (*6*) glass cutter; (*7*) glass

2 mm smaller than the rule thickness. The bars are held together by screws and butterfly nuts *4*.

An L-shaped notch is cut out at one end of the rule to give support to the glass cutter *6*. For convenience, strips of plywood may be nailed or glued to the rule round the notch, so that the total thickness of the built-up end is 10 to 15 mm.

When using the T-square, move the head along the rule to lay off the desired dimension and fix it in position by the nuts. Place the T-square over the sheet to be cut with the head resting against the sheet edge. Insert the glass cutter into the notch and pull the square along the glass, holding the head firmly against the sheet edge and pressing the cutter to the glass as appropriate.

Job layout is the same as in cutting to templates.

The T-square of Fig. 27 consists of a rule *3*, a handle *1*, a head *5*, and a runner *4* with a screw and a rest-finger *2*. When cutting glass, take the T-square by the handle *1* with your left hand, set the cutter in your right hand against the rest-finger of the runner *4*, and pull the square along the

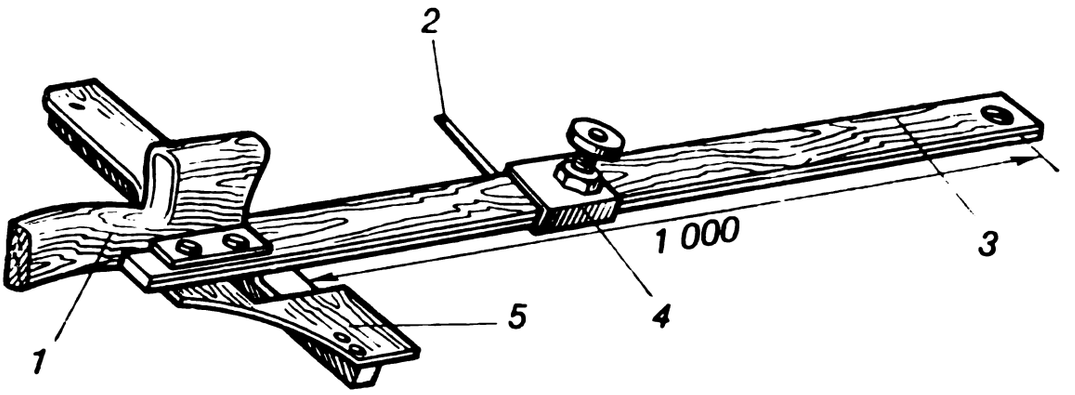


Fig. 27. T-square with a runner
(*1*) handle; (*2*) rest-finger for glass cutter; (*3*) rule; (*4*) runner; (*5*) head

glass sheet. The desired dimension is adjusted by moving the runner along the rule and fixing it with the screw.

A *straightedge may be placed on nails* driven into a table or bench as shown in Fig. 28. Here, one edge of the table is

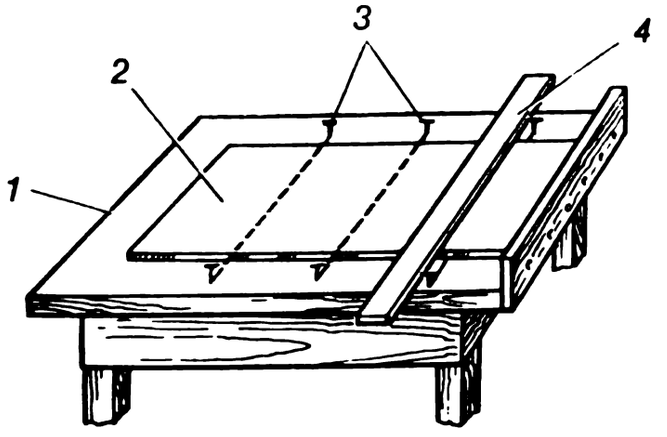


Fig. 28. Cutting glass against a straightedge placed on nails
(*1*) table; (*2*) glass; (*3*) nails; (*4*) straightedge

trimmed with a wooden strip which serves as a rest for the glass sheet to be cut. Nails *3* are driven in pairs on two opposite sides of the table within a desired distance of the trimmed end. With this approach, we begin the cutting a sheet of glass into strips of desired width. Then, we lay

one such strip *2* down on the table with one end resting against the wooden strip. After that, we put a straightedge on two opposite nails *3*, set the glass cutter against the straightedge, and make a cut. We repeat the operation until all the cuts are made, take off the straightedge, and break off the panes, placing the glass with the cuts over the edge of the table. The panes are stacked on a rack or put in a box.

Where a large number of panes is to be cut and the glass cutter used is adequately sharp (so that no tapping is required to deepen the cut), scored sheets of glass may be broken over the edge of the table in a stack. To avoid injuries, the nail heads should be wrapped in cloth or rubber.

18. Cutting Curved Shapes

Curved shapes should preferably be cut to templates. The template dimension should be chosen with allowance for the cutter (to be exact, half the cutter's width should be subtracted every time). On some occasions, glass may be cut to patterns drawn on the table top or on a sheet of paper.

Where a *round shape* is to be cut (Fig. 29*a*), put a tem-

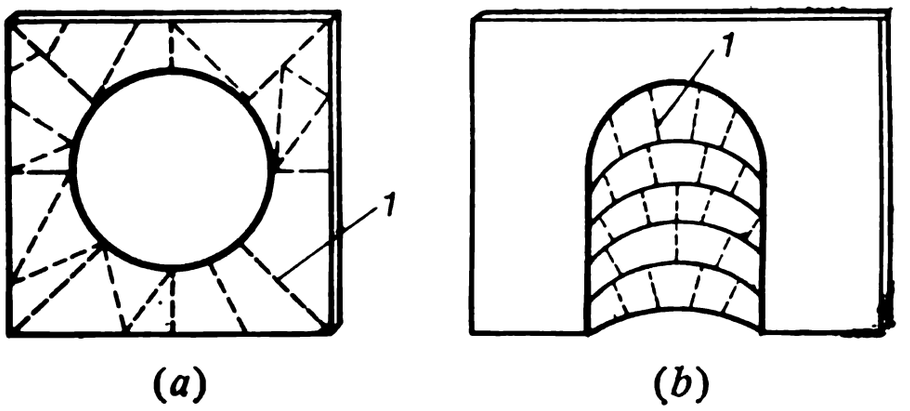


Fig. 29. Cutting curved shapes (*1*—cuts)

plate down on the sheet of glass and hold it in place by hand or with a suitable weight. Set the cutter against the edge of the template and make a round cut. Then, make straight cuts as shown by the dashed lines in the figure so that small fragments can be chipped off.

The shape of Fig. 29*b* is cut in a somewhat different manner. To begin with, place a suitable template on a sheet of glass and make a cut around the periphery, holding the template down by hand or with a weight. Then, make se-

veral cuts inside the outlined area as shown in the figure and break off small fragments of glass, using the slots in the cutter head or pliers having their jaws wrapped in rubber or cloth.

The sharp edges are finished with a honing stick or a piece of abrasive cloth or paper. In so doing, wear protective gloves to avoid injuries.

19. Cutting with Electric Cutters

Where an electric glass cutter is available, proceed as follows. Lay a sheet of glass down on the table, set the straightedge in a desired position, and turn on power (max. 35 V). The wire quickly heats up leaving a mark on the bottom surface of the glass, while the top of the glass remains cold. The glass cannot resist this temperature difference and breaks right along the wire. Once a cut is made, set the straightedge in another position. Up to 200 cuts per hour can be made in this way.

Wire glass can be cut with a type ERG-1 electric glass cutter or a special rig. If no electric cutter is available, it can be cut by hand in the following manner. To begin with, make a cut with a wheel-type cutter on the smooth side of a glass sheet. Then use a hard-steel hook to rake out a groove along the cut to expose the wire mesh, scraping off small chips as you pull the hook along. Turn over the sheet so that the groove faces down and break the glass along the groove. Cut the wire with tin snips. Sometimes, an extra groove may be scratched on the opposite side of the sheet to facilitate breaking. Wear safety goggles to protect your eyes against flying chips of glass.

Figured and corrugated (or *prism*) glass comes in sheets with one surface more or less smooth. This kind of glass may be cut with both electric and hand cutters, cuts being made on the smooth side. Panes are broken off in the regular fashion.

20. Safety Precautions

Be sure that boxes containing glass sheets remain upright when carried from place to place and put on the floor. Be careful when opening the boxes and taking the glass

sheets out, because the sheets may easily break and injure your hands. Wear canvas or rubber gloves when handling glass. Take out broken glass from the boxes piece by piece, beginning with the larger fragments.

NEVER cut glass on your knees or makeshift supports.

NEVER wipe off glass dust from cuts with bare fingers.

Use suckers for handling dry and clean glass only, for they may lose their hold if the sheets are dirty or stained with oil. At sub-zero temperatures, their holding capacity may drop by as much as 15% when the glass is in a horizontal position and by 20% when it is in an upright position.

Be sure to break off panes of glass away from the cut. Put rubber caps on the jaws of the pliers or wrap the jaws in cloth, leather, or insulating tape.

Lean glass sheets on a firm support at up to 15° with the vertical. Take care to wipe off glass dust from the tables and benches every hour with a dry brush. Wear safety goggles as you do so. NEVER blow off the dust or wipe the tables with bare hands.

Wear gloves when grading and handling glass.

NEVER leave glass sheets or fragments on the scaffold. NEVER drop them from the platforms or cradles.

Handle electric cutters with care to avoid burns or shocks.

Inspect your tools and accessories before work. Rectify all defects or replace faulty tools.

Beat the dust out of your clothes every day to remove tiny glass particles. Wear safety goggles as you do so.

Chapter Seven

Placing Window Glass in the Sash

21. General

Glazing (as the process of placing glass in the sash is commonly called) should be carried out before hanging wallpaper or painting walls and other building components. It should be remembered that glazier's putty and glazing compounds generally refuse to stick to dusty surfaces. In

view of this, the rabbets in the door leaves and window sash should be cleaned from dust and dirt (preferably with a rag or a stiff-haired brush), washed, allowed to dry, and given a coat of drying oil if this has not been done before installation. It is strictly forbidden to glaze wet sash.

The windows of apartment houses and office buildings should be glazed with whole panes only. No jointing is allowed here. Faulty or indelibly stained glass may not be used.

In industrial buildings, a certain percentage of jointing is acceptable so long as the client has nothing against that. Here, no more than two panes may be used to a sash, provided they are held in position by at least two clips, properly overlapped (the width of overlap being up to 20 mm large), and covered with putty on either side.

Unless otherwise specified, other types of flat glass are placed in the sash in much the same way as window glass.

Glass is held in position by sprigs and glazing beads in wooden sash and by glazing beads and pins in metal sash. Plastic sash are glazed very much like metal sash, the lights of glass being fixed by beads and fillets.

Glazing beads are fastened with nails or wood screws so that they bear against, and do not detach themselves from, the glass. Wedge-operated clamps are spaced 300 mm apart.

Bed putty is placed on the rabbets so that it fills them completely. It is important that it be well levelled and smoothed off with a putty knife. Sprigs, staples, clamps, and other fasteners should be covered level with the putty's surface.

Where glass is held in place by glazing beads, the outer bevels of the beads should be level with the exterior sides of the rabbets. In the corners, the beads should be properly mitred so that they make a tight joint.

Rubber pads, gaskets, seals and similar parts should be placed snug against the glass, rabbets, and glazing beads. Glazing beads should be pressed to the gaskets and rabbets to an even bearing and reliably secured in place. Parts of the rubber gaskets, which have been squeezed out of the joints, should be cut off flush with the glazing beads.

In winter, glazing may be carried out in heated rooms

only at a temperature of not less than 10°C. Glass sheets which have been stored outdoors for a long time should be cleaned from snow and ice and allowed to warm up for at least two days until moisture dries out completely. Glazed sash are stacked rabbets up to prevent the putty from sagging or running off. They may be taken from the heated room outdoors and hung after the putty has set, usually in two or three days.

Outdoor glazing may be allowed only where the sash cannot be unhung and taken to a heated room (as may be the case with factory windows, monitors, show-cases, tiered windows, and the like). If so, the putty or glazing compound used should be heated to about 40°C.

22. Fixing Glass in Wooden Sash

In wooden sash, panes of glass, *2*, are secured in position by sprigs *1* (Fig. 30) or glazing beads. Use may also be made

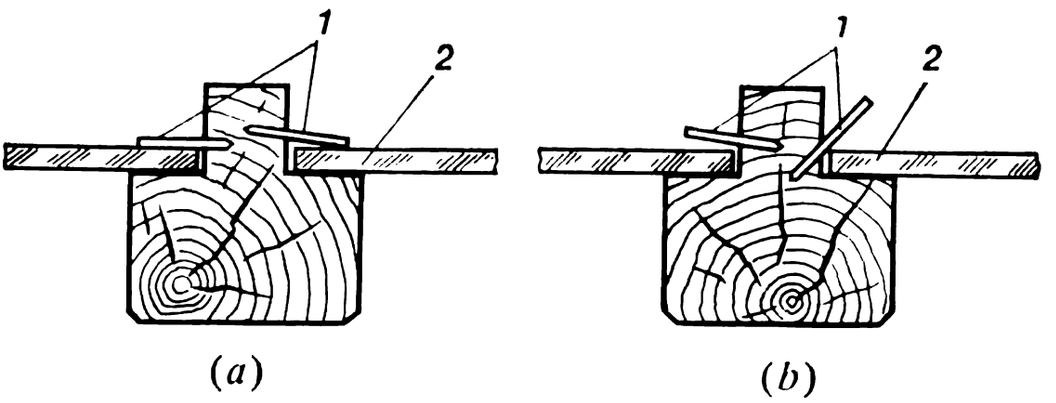


Fig. 30. Fixing glass by sprigs
(*a*) right; (*b*) wrong; (*1*) sprigs; (*2*) glass

of round or triangular glazier's points cut out of a sheet of roofing steel or staples. These may be driven by hand or by means of a stapler. Small brads or nails also find application.

The sprigs are spaced 300 mm apart (or 200 mm apart in ventilators).

When driving the sprigs into the sash, be sure that they run parallel to the glass surface or have their free ends directed slightly away from the pane. In the former case, the entire length of the sprig will support the glass, while

in the latter, the job will be done by the tip only. Do not allow the sprig tips to rub against the pane, because this may break it.

The glazing procedure is illustrated by Fig. 31. To begin with, roll a length of wire into a coil and take it with your left hand (if you are a right-handed person). Take a wood

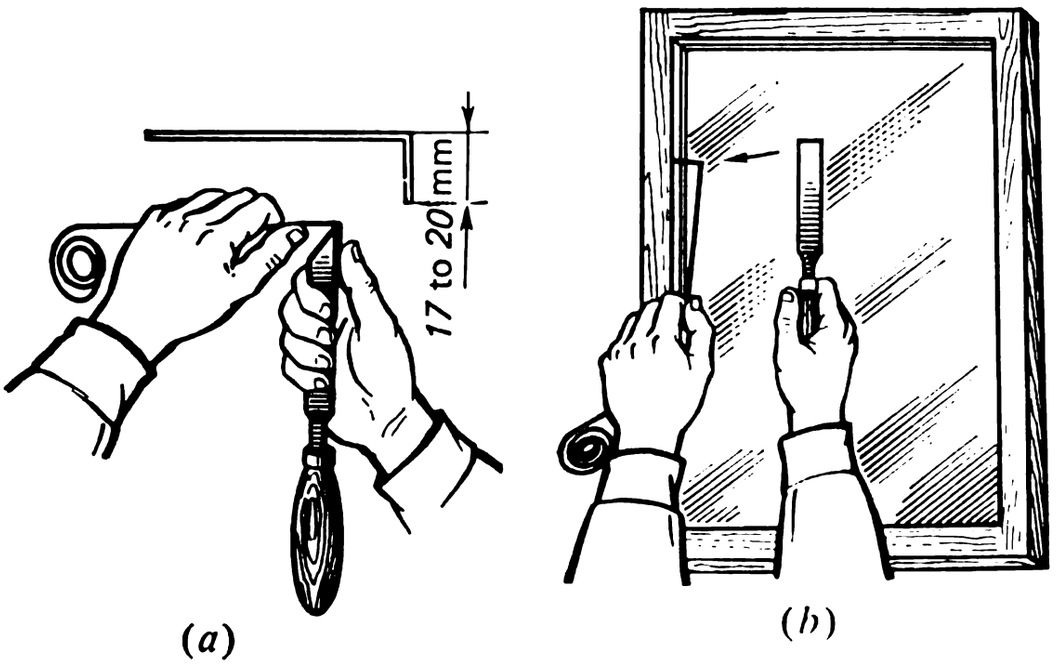


Fig. 31. Fixing the glass with sprigs by hand
(*a*) making a hook; (*b*) driving a sprig into the rabbet with a wood chisel

chisel with your right hand and bend the end of the wire (15 to 20 mm) at right angles over the chisel blade, holding it with the right thumb as shown in the figure. Set the wire to the glass and strike several sideway blows with the wood chisel to drive the hooked portion into the wood for half its length or slightly farther. Then, give the wire two or three twists at the bend to break off the unused portion*.

Small nails may sometimes be used instead of sprigs. In this case, press a nail to the glass with your left fore-

* Perhaps, it will be revealing for the reader to learn that what we get is called a sprig. In fact, it is not. In UK and US glazing practice, the term "sprig" refers to a small headless nail (for example, see "A Dictionary of Building" by John S. Scott, Penguin Books, 1984). In this text, which is predominantly based on Soviet practice, it is used just to give an idea about how glass is fixed in the sash, rather than to mean the real thing.—*Translator's note.*

finger and strike several sideway blows with a wood chisel in your right hand to drive it to the desired depth. Any sprig (or nail for that matter) should be driven in such a way that it may fully be buried in the face putty (Fig. 32).

Wire sprigs, glazier's points, and staples can be driven into the rabbets by means of mechanical or air-operated guns and staplers.

The mechanical sprig-driving gun shown in Fig. 33*a* cuts wire into short pieces and drives the pieces into the

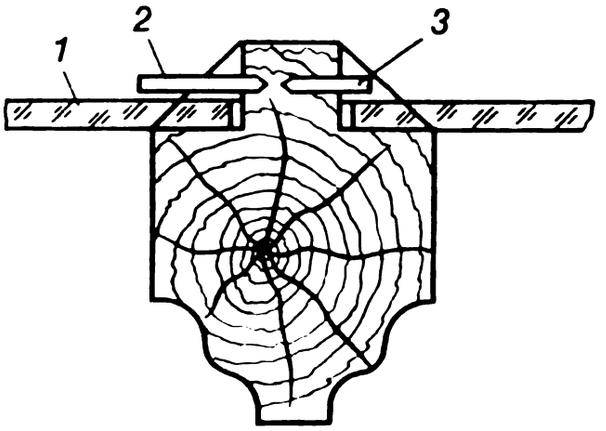


Fig. 32. Position of sprigs in a rabbet
(*1*) glass; (*2*) wrong; (*3*) right

sash in one operation. Here, the wire *3* is driven through the tip into the wood by the grip *1* and clipped by the built-in nippers.

The mechanical gun of Fig. 33*b* is a spring-loaded tool. The force developed by the spring can be adjusted to suit particular requirements (namely the toughness of the wood and the desired hold of the points). The gun can drive up to 500 glazier's points per hour. Glazier's points are made of roofing steel 0.5 mm thick and given the shape of an isosceles triangle with a base of 8 mm and a height of 11 mm.

A pack of points (70 to 80 points per pack) is inserted into the magazine *6* and pressed by the fork *7* to the guide clip which prevents the points from falling out. Depressing the trigger *2* once cocks the strike. The strike is held cocked by the stop catch. A second depression releases the strike which picks up a glazier's point and forces it into the rabbet. The vacant space is immediately occupied by another point. In operation, the gun should be pressed both to the glass

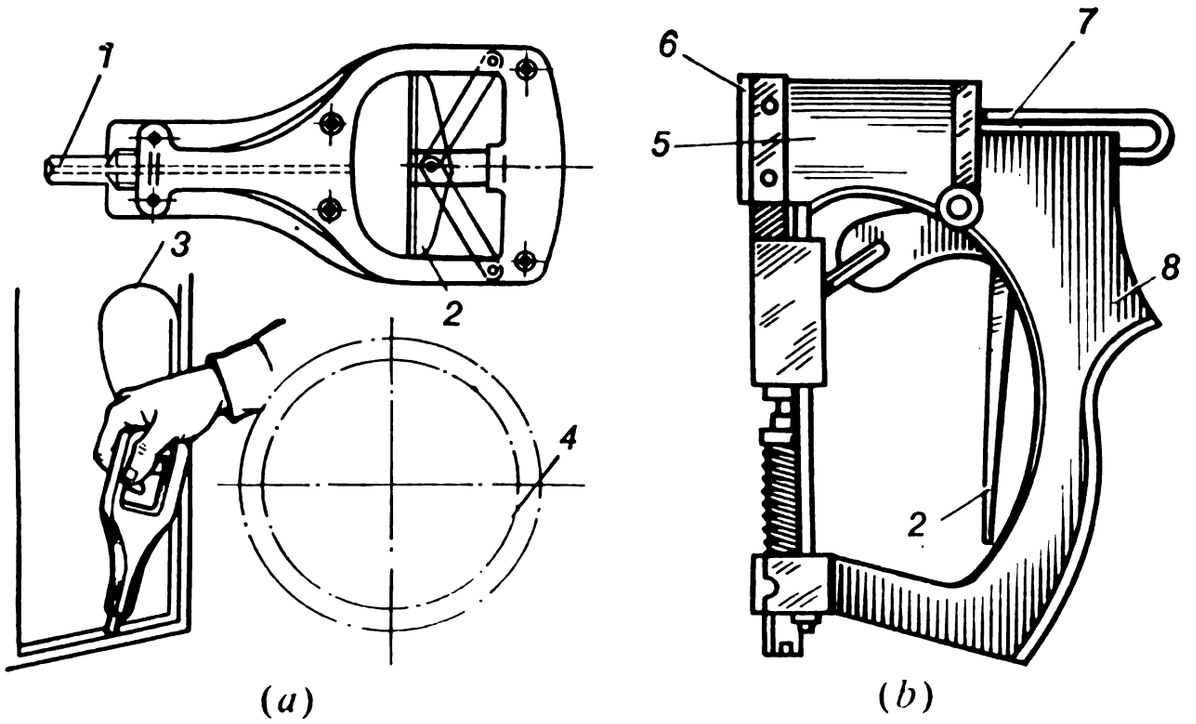


Fig. 33. (*a*) Mechanical sprig-driving gun; (*b*) mechanical point-driving gun
(*1*) guide tip; (*2*) trigger; (*3*) wire; (*4*) coil of wire (shown schematically); (*5*) case; (*6*) magazine; (*7*) fork; (*8*) handle

and to the rabbet to make sure that the point being driven is snug against the glass pane.

The air-operated stapler of Fig. 34 can drive up to 120

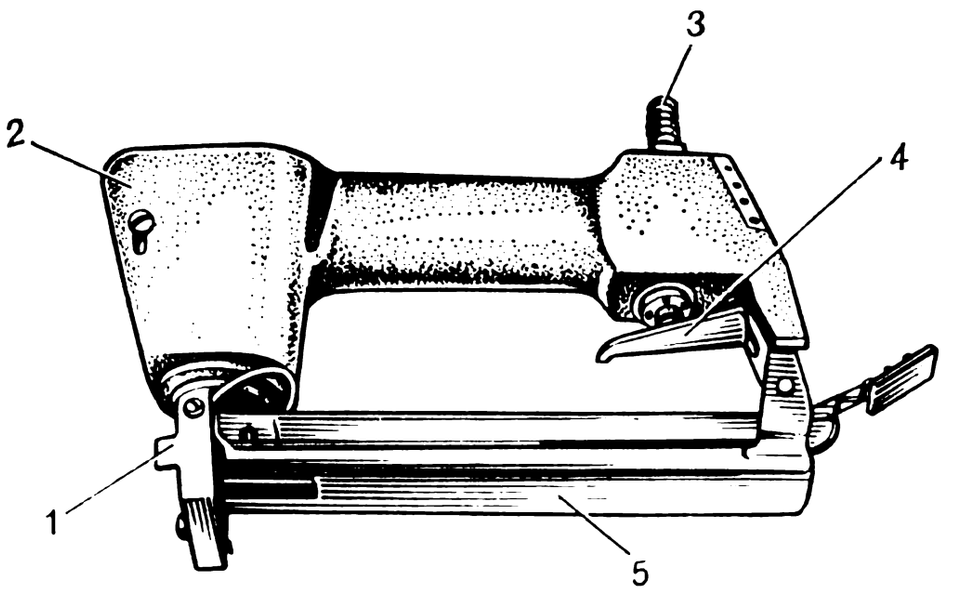


Fig. 34. Air-operated stapler
(*1*) strike; (*2*) case; (*3*) union; (*4*) trigger; (*5*) staple clip

wire staples per minute to a depth of 15 mm. Its magazine can hold 150 U-shaped wire staples 20 × 5 mm in size

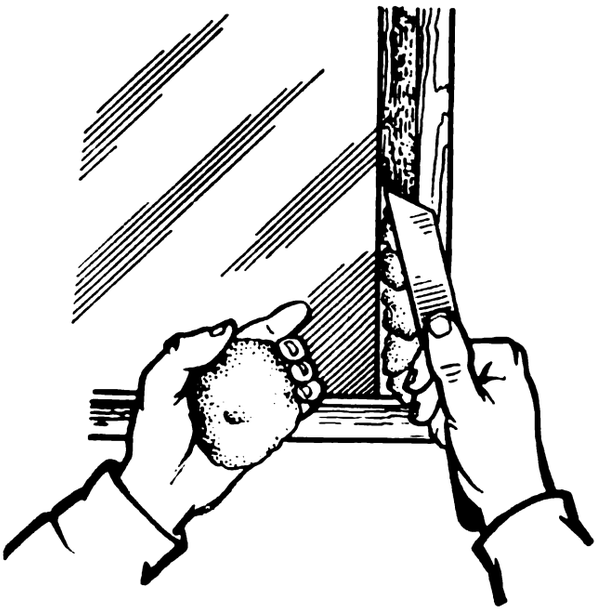


Fig. 35. Placing bed putty (bedding)

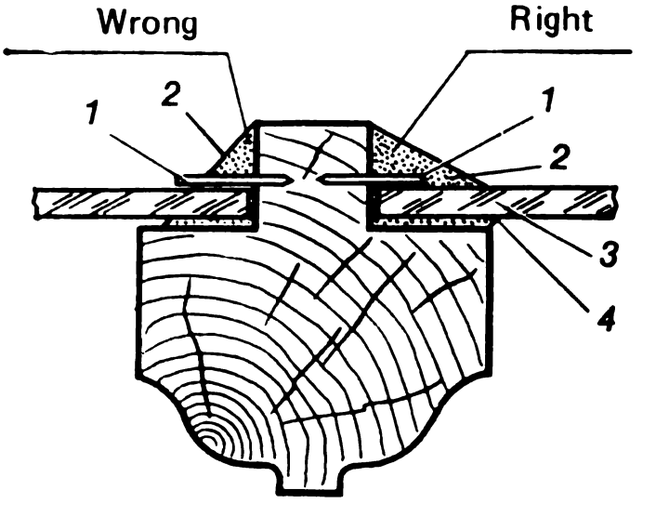


Fig. 36. Cross section through a bar of a glazed window (*1*) sprig; (*2*) face putty; (*3*) glass; (*4*) bed putty

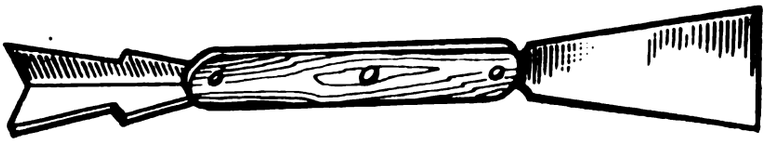


Fig. 37. Double-blade putty knife

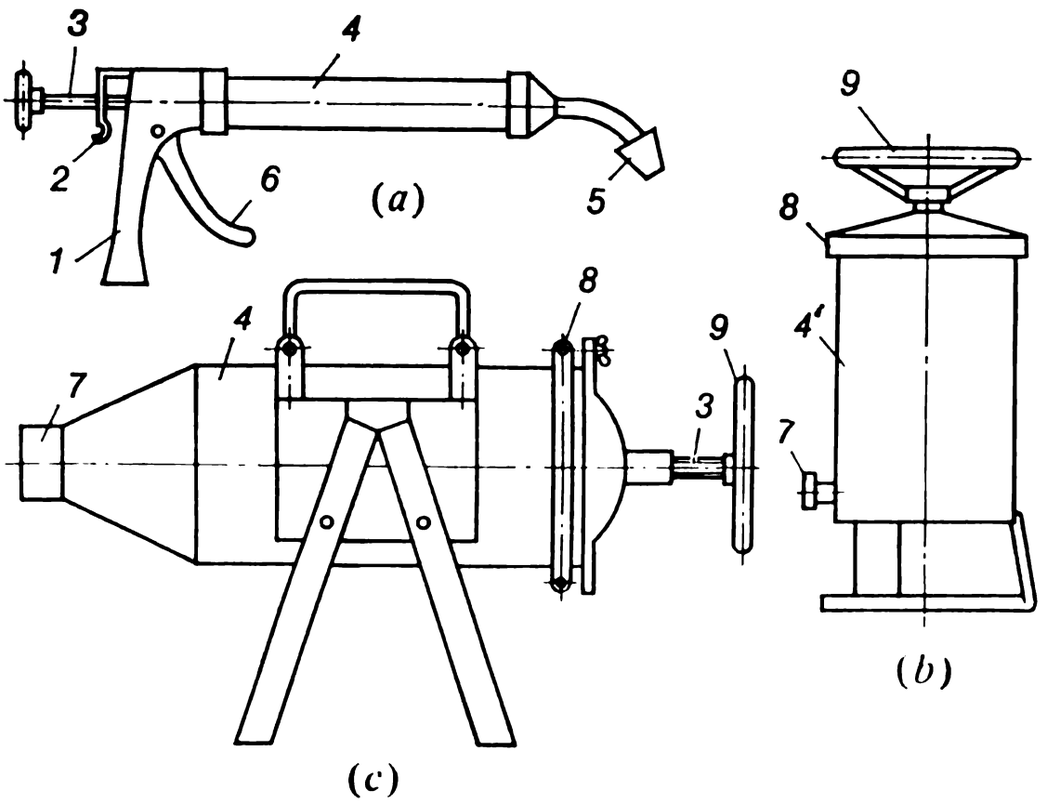


Fig. 38. (*a*) Pressure gun, (*b*) and (*c*) filling tanks; (*1*) handle; (*2*) stop catch; (*3*) piston rod; (*4*) barrel; (*4'*) case; (*5*) nozzle; (*6*) trigger; (*7*) branch pipe; (*8*) lid; (*9*) handwheel

and 0.9 mm in diameter. The tool is supplied with air compressed to 0.5 MPa.

23. Placing Putty on Sash Rabbets

As previously mentioned, it is desirable to place putty on the rabbet of the sash before the glass is set. Where bed putty is to be applied manually (Fig. 35), take a clod of putty with your left hand and a putty knife with your right hand (if you are a right-hander). Pick up some putty with the knife blade and place it on the rabbet as shown in the figure. As the rabbet is filled with putty, move the blade lengthwise while exerting light pressure to bring the putty to an even surface. Strike off surplus material and return it to the clod in your left hand for re-use. Within the same sash, the ribbons of putty should be of equal width (Fig. 36).

Bed putty can be applied with a double-blade knife (Fig. 37). The flat blade is used to place the putty on the rabbets and the angle blade serves to bring the putty to a true surface.

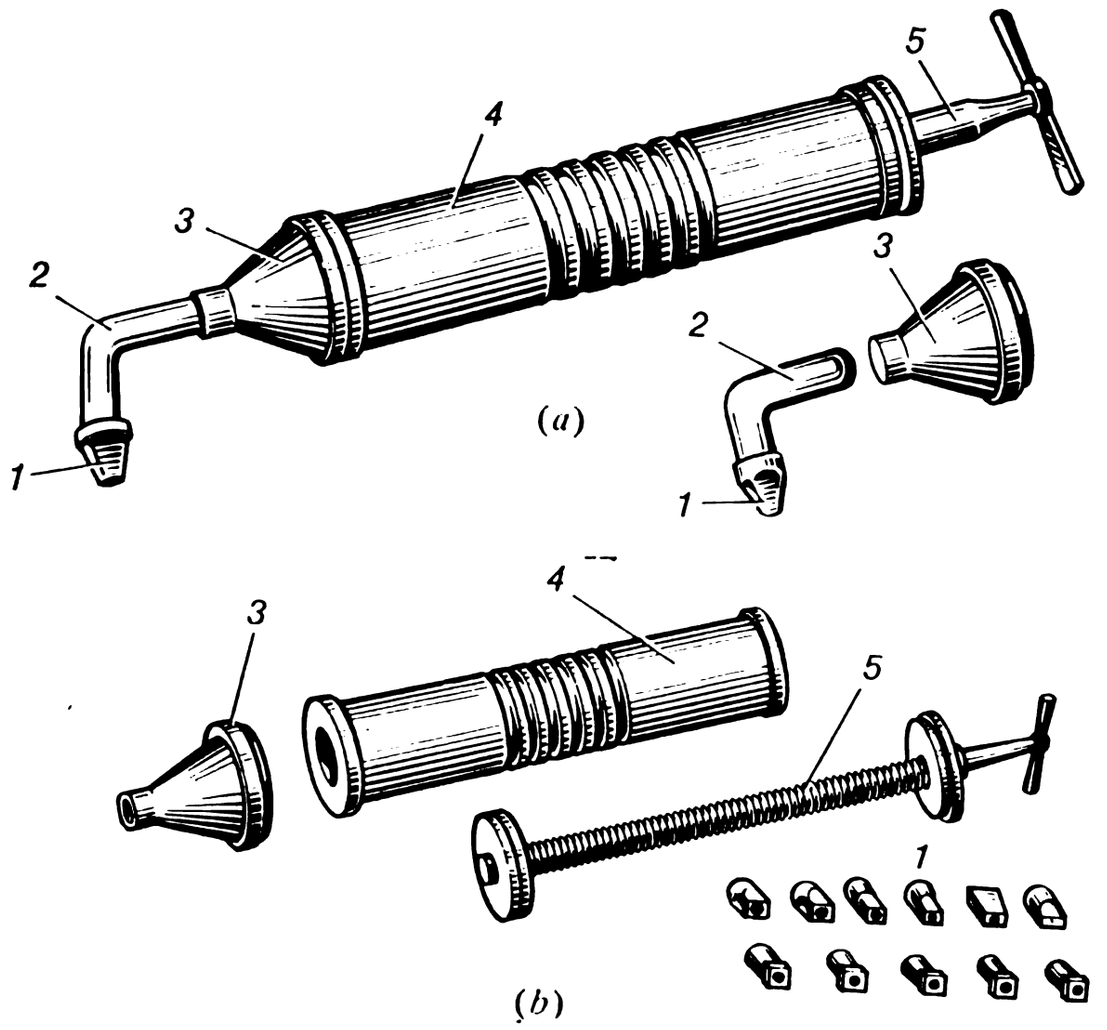
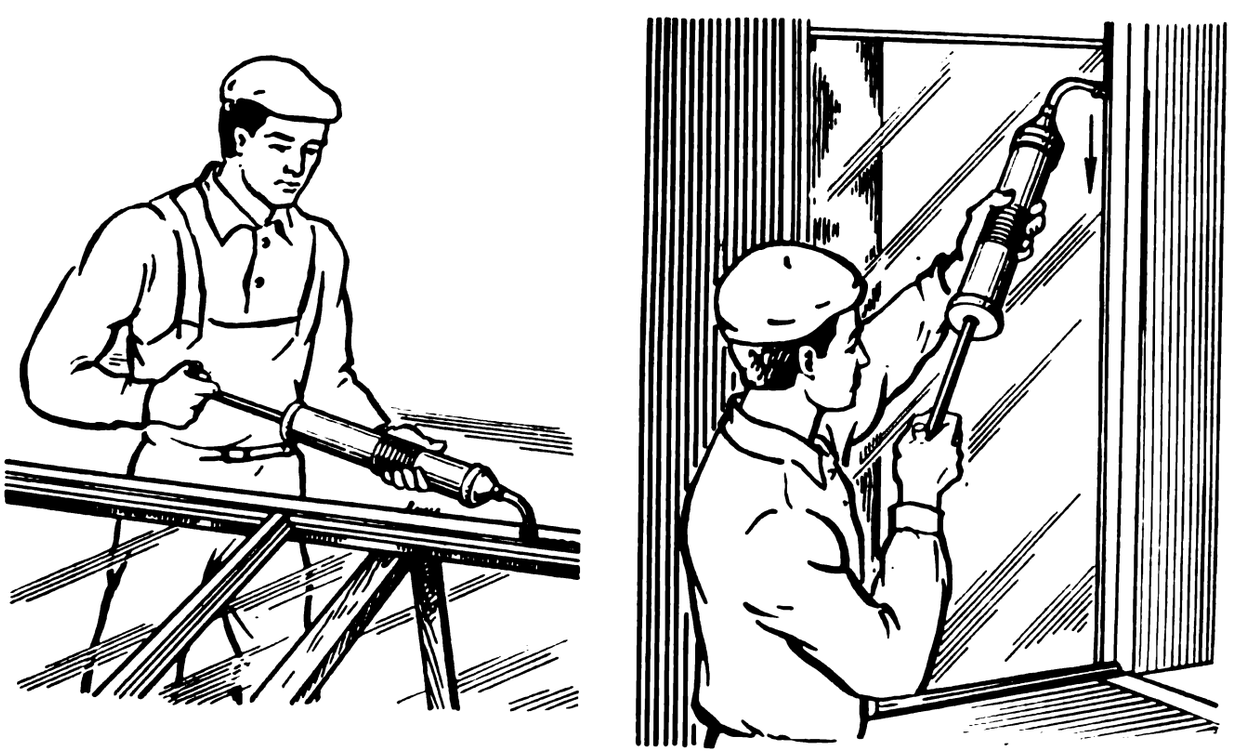


Fig. 39. Pressure gun
(*a*) general appearance; (*b*) component parts; (*1*) accessory nozzles; (*2*) discharge tube; (*3*) conical adapter; (*4*) cylindrical barrel; (*5*) piston rod

To speed up the process, use is widely made of pressure guns. The pressure gun of Fig. 38*a* is employed for applying glazier's putty, glazing compounds, or mastics to window bars and also for filling the gaps left between the edges of the rabbets and the glass.

The tool, whose mass does not exceed 1 kg, consists essentially of a barrel *4* with a piston rod *3* at one end and a nozzle *5* at the other. The gun comes complete with four accessory nozzles of various diameter for different jobs. It is loaded with reusable cartridges packed with putty. The capacity of the cartridges is 0.35 l. The putty is forced out of the cartridge by a feed mechanism consisting of a piston with the rod *3*, a handle *1*, a spring, a trigger *6*, a stop catch *2*, and a clip.

Fig. 40. Filling a pressure gun with putty
(*1*) filling tank; (*2*) handle; (*3*) pressure gun



(*a*) (*b*)

Fig. 41. Applying putty by a pressure gun
(*a*) sash lying flat; (*b*) sash hung on hinges

The cartridges are packed with putty or glazing compound, using a filling tank (Fig. 38*b*). The filling tank consists essentially of a case *4'* with a lid *8* at one end and a threaded branch pipe *7* at the other. Cartridges to be filled are screwed on the branch pipe. The tank also has a piston which moves along a threaded rod actuated by a handwheel *9*. As the rod is rotated by the handwheel, the piston comes down and squeezes the putty out of the branch pipe into the cartridge. To refill the tank, the lid *8* is removed and the rod *3* is screwed out to lift the piston.

The pressure gun of Fig. 39, which comes complete with accessory nozzles and a filling tank, uses putty of more plastic consistency than ordinary putty applied by hand. As a rule, the putty contains 30% drying oil and 70% whiting (3.6 kg of whiting per kilogram of drying oil).

The main component of the pressure gun is a cylindrical barrel *4* which is 280 mm long and 65 mm in diameter. The barrel has a cap at one end and a conical adapter *3* at the other. The narrower end of the adapter receives a discharge tube *2* with a nozzle *1*. The barrel houses a piston which is set in motion by a threaded rod *5* actuated by a handle. The thickness of the putty bead can be varied by using nozzles of different diameter. The total mass of the pressure gun is 1 250 g. The barrel can hold about 2.5 kg of putty.

The gun is filled with putty as shown in Fig. 40. For this purpose, we remove the conical adapter and screw the gun on the branch pipe of the filling tank. Then, we screw out the piston rod as far as it will go and turn the handle of the filling tank. As the handle is rotated, the piston inside the tank forces the putty out of the branch pipe into the gun barrel. The time of filling does not usually exceed 30 s.

To apply putty, take the gun with your left hand, set the nozzle to the rabbet, and turn the handle with your right hand (if your are a right-hander). As you do so, the putty is squeezed out of the nozzle, forming a narrow bead. Move the gun towards or away from yourself if the sash lies flat (Fig. 41*a*) or from top to bottom if it hangs on hinges (Fig. 41*b*). Smooth out the putty directly with the tip of the nozzle or use a putty knife.

24. Glazing with Face Putty Alone

Fixing glass with face putty alone is the simplest glazing technique. Panes of glass are cut to size, the rabbets are cleaned from dirt and dust, and the glass is set in the rabbets so that the gap between the edges of the pane and rabbets is the same on all sides. Where glass is set in a hanging sash (Fig. 42), the pane *2* is placed on the rabbet in the bottom rail, fixed by sprigs *4*, and puttied.

Simple and economical of materials as it may be, this approach is only used to glaze openings in temporary structures and cold verandas. Here, the rabbets do not always lie in the same plane for various reasons (warped and twisted rails and stiles, poor manufacture, etc.). As a result, the glass is very hard to press to an even bearing. This drawback may not be rectified by manipulating the sprigs, for this may easily break the glass if the pressure is too large. So, a gap *1* is always left between the rabbets and the glass, through which water is free to leak in from the outside, thus speeding up decay. Also, wet stiles and rails swell and may exert undue pressure on the glass, sometimes breaking it completely if the gap is too narrow for the window bars to increase in volume. Wetting results in twisting and warping, which also facilitates breakdown. On the other hand, wide gaps entail heat losses and, hence, a greater heating bill.

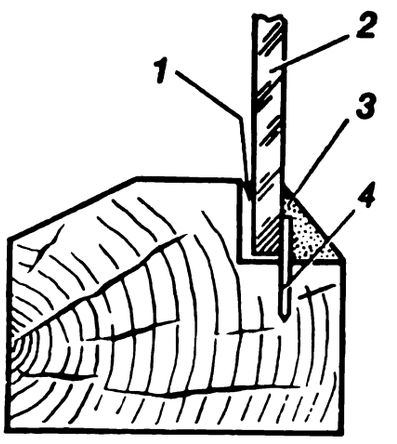


Fig. 42. Glazing with face putty alone
(*1*) gap between rabbet and glass; (*2*) pane of glass; (*3*) face putty; (*4*) sprig

As for metal sash, water leaking in through the gaps brings about corrosion.

25. Bed- and Face-Puttying

A far better way of fixing the glass in the sash is by means of bed and face putty.

Bed putty is placed on the rabbet of the sash before the glass is set. Quite appropriately, this operation has come to be known as bedding or bed-puttying. Putty is applied by a pressure gun or a putty knife as a continuous bead 2

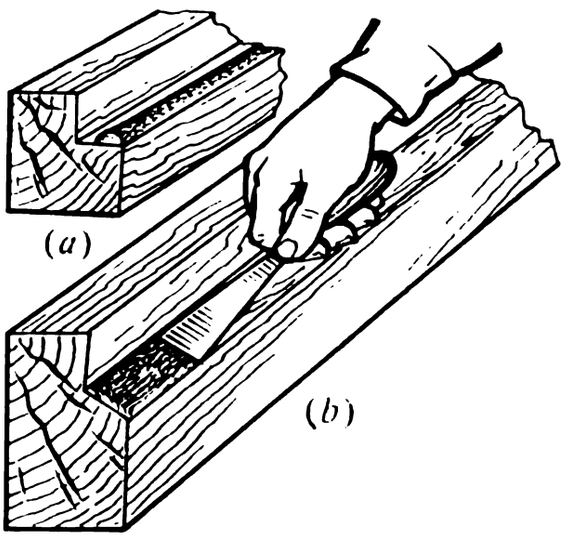


Fig. 43. Bed putty applied
(*a*) as a bead; (*b*) as a ribbon

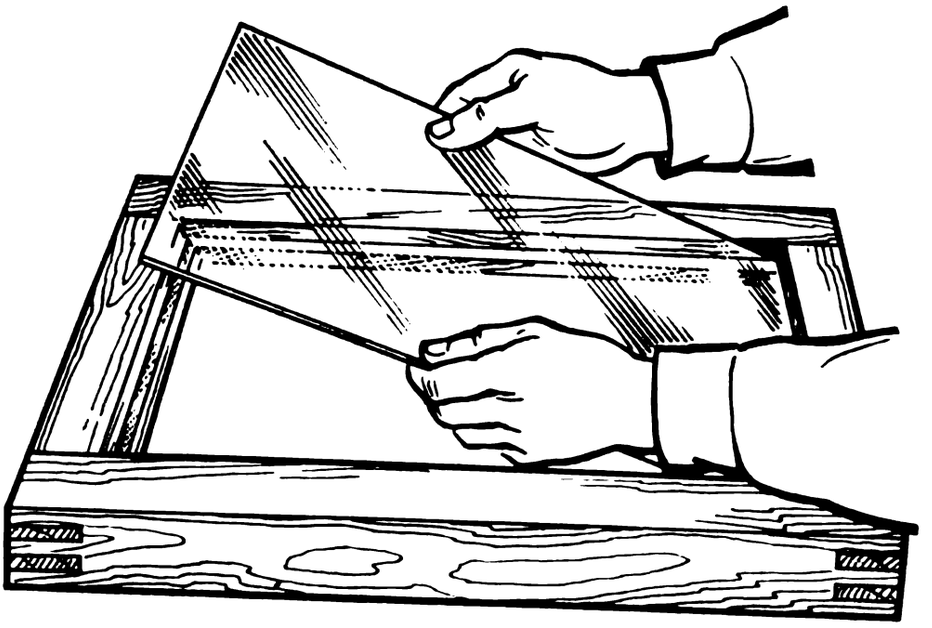


Fig. 44. Setting the glass into the rabbet

to 5 mm thick (Fig. 43*a*) or ribbon up to 3 mm thick (Fig. 43*b*). In the latter case, the putty covers the entire width of the rabbet.

Glass is put on the rabbets so that a uniformly wide gap is left between the edges of the pane and rabbets (Fig. 44). The pane is pressed into the putty to an even bearing until surplus material is squeezed out of the gaps, leaving a thin bed of putty (Fig. 45).

If the putty and the glass have been placed correctly, no unfilled gaps will be left. After it has been set in the sash, the glass is fixed in position by sprigs driven by hand or by

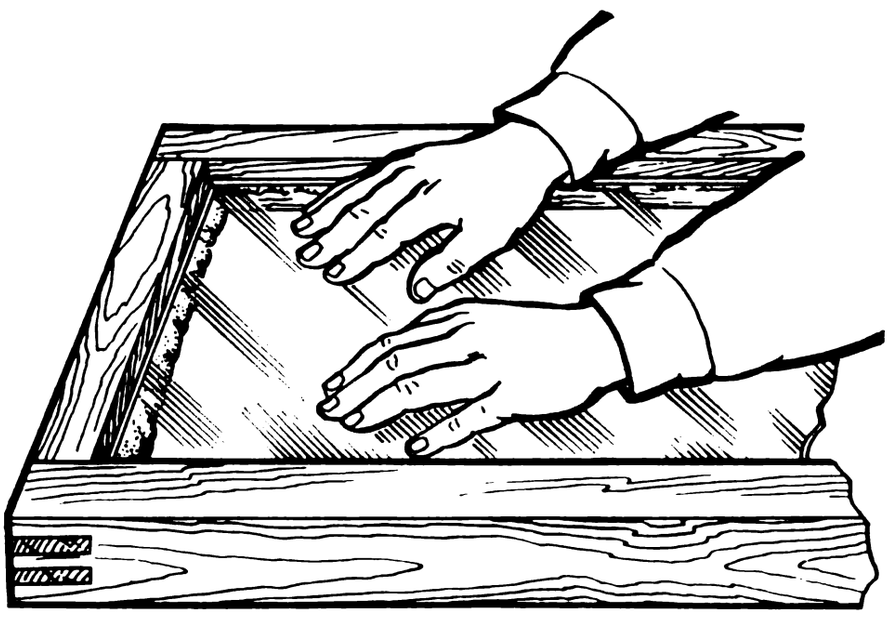


Fig. 45. Pressing the glass into the bed putty

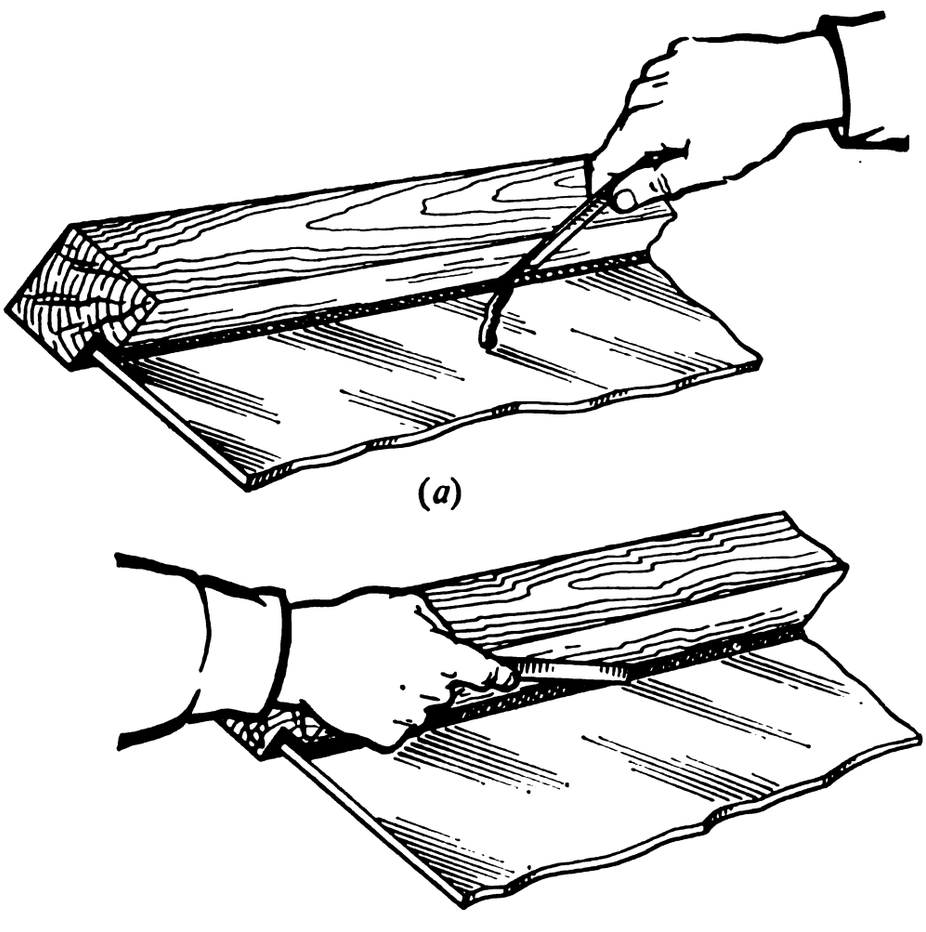


Fig. 46. (*a*) Striking off surplus bed putty; (*b*) trimming the edge

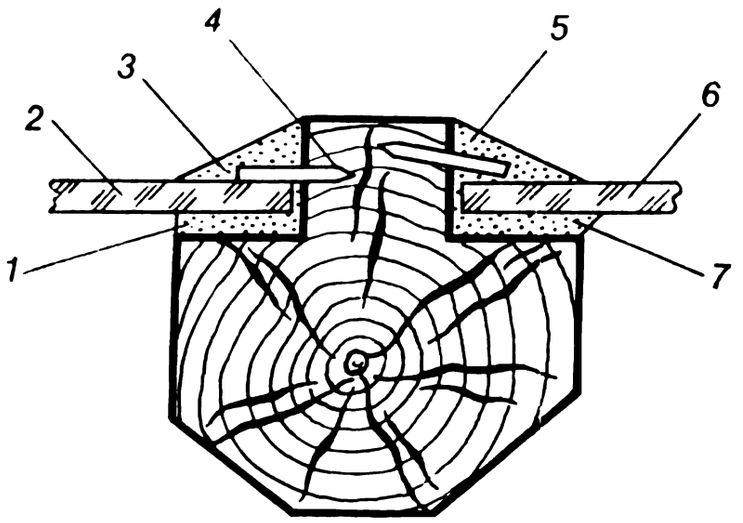


Fig. 47. Fixing the glass with bed and face putty
(*1*) bed putty struck off at right angles; (*2*) and (*6*) glass; (*3*) and (*5*) face putty; (*4*) sprig; (*7*) bevelled bed putty

means of a gun. The remainder of the rabbet is then filled with putty applied by a pressure gun or a putty knife, and smoothed off by use of a putty knife. This is called face-puttying*.

Surplus bed putty squeezed out of the rabbets when placing the glass is struck off at right angles or forming a bevel (Fig. 46). A section through a bed- and face-puttied window sash is shown in Fig. 47.

Bed- and face-puttying seals the sash tightly and prevents heat losses.

26. Fixing Glass with Glazing Beads

As already mentioned, glazing beads (or glass stops, as they are also called) are small hardwood strips, mitred and nailed or screwed round a rabbet, to hold the glass instead of face putty. They not only help to save putty, but also make the glazed sash look more pleasing to the eye.

The nails and wood screws fastening the beads to the rabbet are spaced 300 mm downwards apart. A gap of 3 to 5 mm should be left between their heads and the pane to prevent the glass from breaking.

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* Another operation, known as back-puttying, consists in forcing putty into any spaces which may be left between the edges of the rabbet and the glass.—*Translator's note.*

Glazing beads may be placed in many ways. For example, the glass may be put directly on the rabbet and fixed by glazing beads with no putty.

As an alternative, the glass may be placed on a thin bed of putty, pressed into the putty to an even bearing, and then secured with glazing beads. In this case, surplus putty is struck off and the edges are trimmed with a putty knife.

In another technique, both the glass and glazing beads are placed on a layer of putty (Fig. 48). Here, the glass *2* is pressed into a bed of putty, *1*, to an even bearing. Then the glazing bead *3* is coated with putty on one or two sides, placed in position, and fastened by wood screws *4*. Surlpus putty is struck off and the edges are trimmed in the regular fashion.

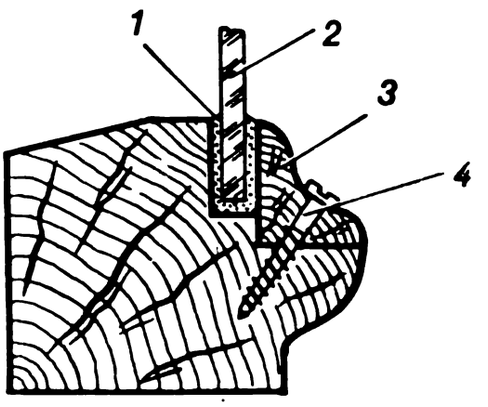


Fig. 48. Fixing the glass by a glazing bead on a bed of putty
(*1*) bed putty; (*2*) glass; (*3*) glazing bead; (*4*) wood screw

Glazing beads may also be bedded in U-shaped seals or gaskets (Fig. 49*a*) or rubber tube (Fig. 49*b*). These are fitted over the glass as shown in the figure, V-cuts being made in the corners to facilitate bending (Fig. 49*c*). Care should be exercised in making the cuts, so that the corner joints might look like tightly matched mitres. The ends of a seal or gasket should be joined along the top or side rabbets (Fig. 49*d* and *e*). They should preferably be glued to the glass for security. As an alternative, the ends may be sawn or joined by staples *1*. When the glass with the rubber on is placed in the rabbet, a gap of 3 mm should be left between the edges around the periphery of the pane. After the glass has been set in the rabbet, a glazing bead *5* is fastened to the window bars by wood screws *6* or nails. The gaskets should lie flush with the top of the rabbet and glazing bead or sunk for about 1 mm. Protruding parts are cut off with a chisel or a knife (Fig. 49*f*).

In metal sash, the glass is fixed by means of gaskets or bed and face putty.

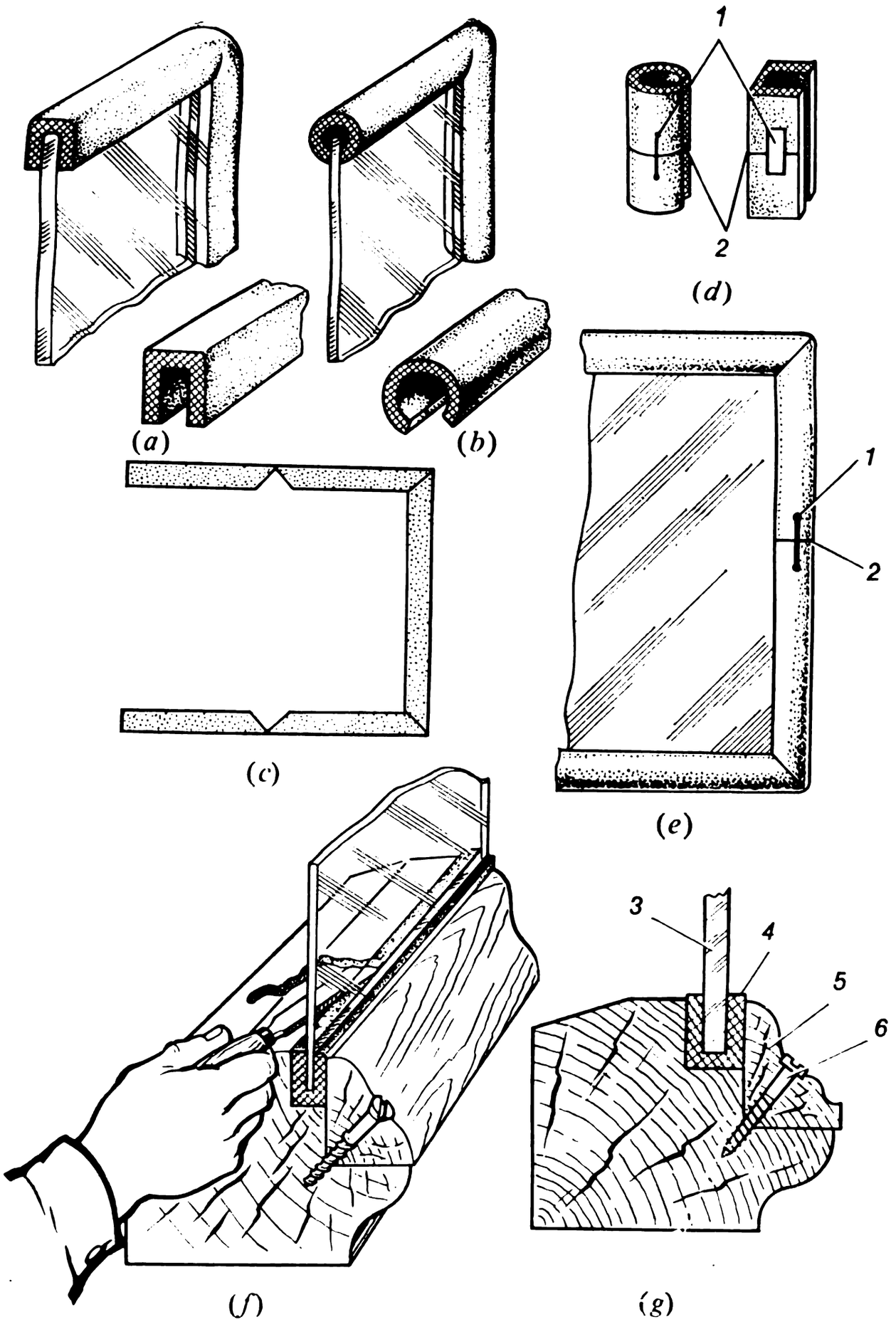


Fig. 49. Fixing the glass by elastic gaskets and glazing beads
(*a*) U-shaped gasket; (*b*) rubber tube; (*c*) V-cuts for mitring; (*d*) joining gasket ends; (*e*) location of a joint; (*f*) cutting off protruding rubber; (*g*) section through a bar of a glazed window; (*1*) staple; (*2*) joints; (*3*) glass; (*4*) gasket; (*5*) glazing bead; (*6*) wood screw

27. Glazing Roof Lights and Greenhouses with Flat Glass

Roof lights of various construction are widely used in industrial buildings, indoor sports grounds, exhibition halls, and the like to secure proper light and ventilation. Their frames are made of metal, reinforced concrete, or (less often) wood. The frames of greenhouses use wood on a wider scale.

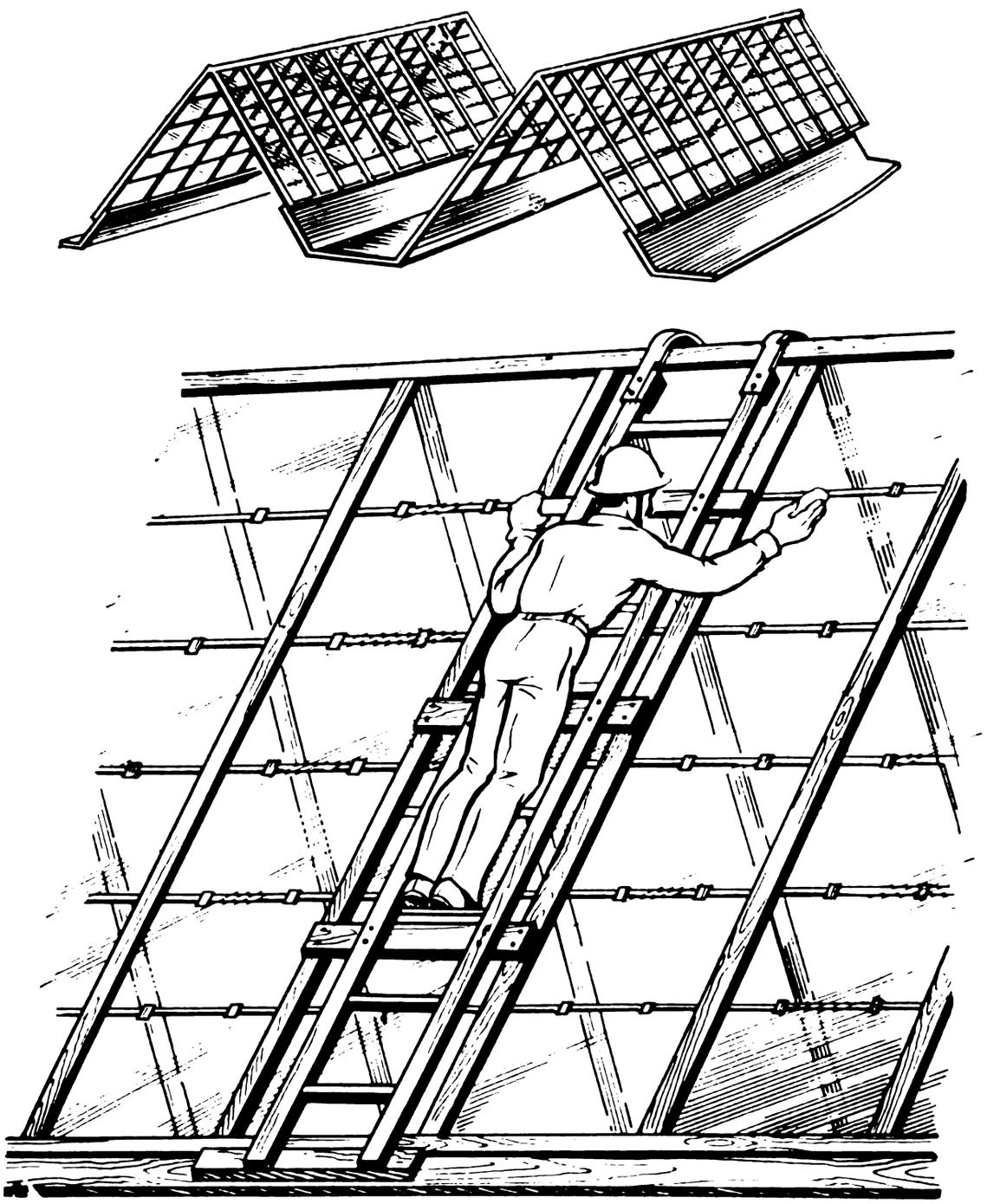


Fig. 50. Roof light (monitor) and a cat ladder

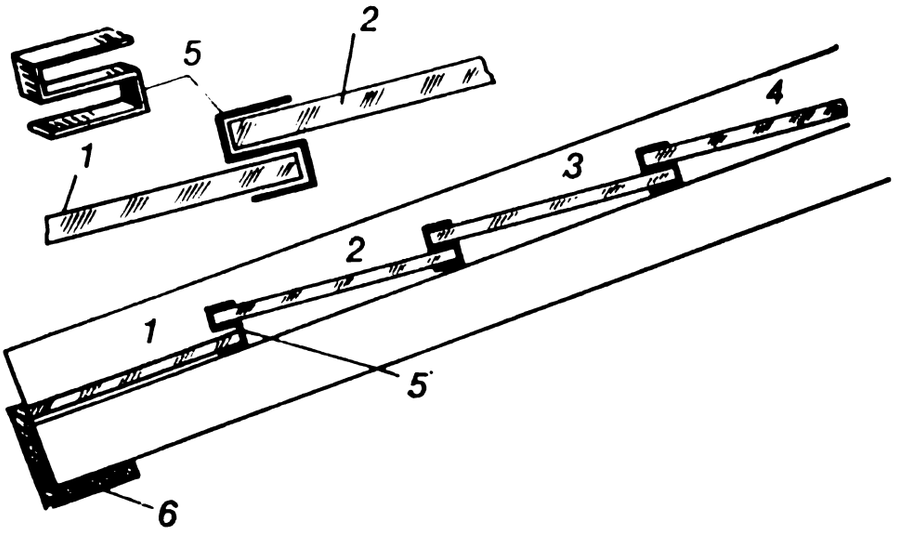


Fig. 51. Fixing the glass in roof lights
(*1*) through (*4*) order of installation of panes; (*5*) clip; (*6*) stop bar

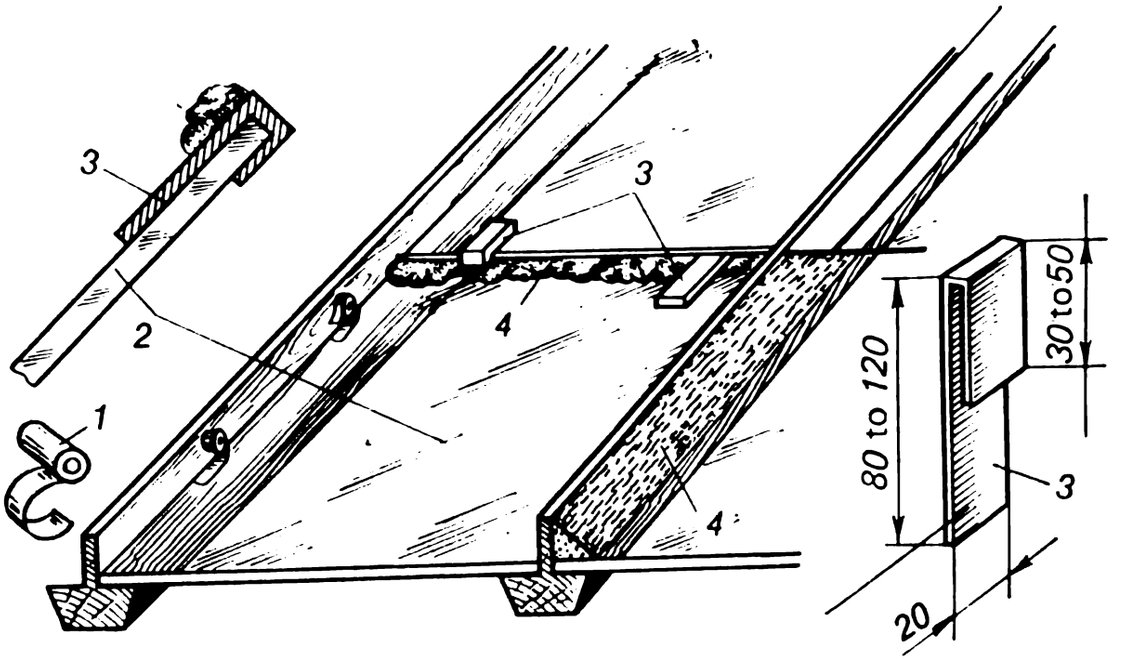


Fig. 52. Fixing the glass with clips, springs, and putty
(*1*) spring; (*2*) glass; (*3*) clip; (*4*) putty

Metal frames and glazing bars have factory-drilled holes to admit pins. If glazing beads are used to secure the glass in position, the holes should be threaded.

Glazing bars are arranged along the roof slope so that they are not in the way when rainwater runs off the roof.

Roof lights are glazed with sheet glass 3 to 6 mm thick.

To facilitate glazing, lights of glass should be cut in advance in the number required for a particular job. Their width or length should be by 2 to 3 mm smaller than the respective rabbet-to-rabbet distance.

The work is done from a cat ladder or duck board, as it is also called, which consists of several boards having a total width of 50 to 60 cm, with cleats 4 × 4 or 6 × 6 cm in cross section nailed on them on one side at a distance of 25 to 30 cm from one another to give support to workmen (Fig. 50). Transverse strips of wood are nailed on the other side of the ladder. These are spaced wider apart and are long enough for them to span across two glazing bars. In plain words, they rest on two glazing bars and give support to the ladder. A thick transverse bar is fixed at the upper end of the cat ladder to catch on the ridge. Sometimes, the stiles of the ladder have hooks serving the same purpose.

Glazing Roof Lights. Here, panes of glass are laid working from bottom to top of the slope. They should be overlapped to prevent heat losses and leaks, the width of overlap being at least 25 mm.

To begin with, place bed putty on the rabbets in a strip 1.5 to 2 m long. Lay the bottom pane *1* (Fig. 51) so that it extends 2 to 3 mm past the lower glazing bar or rests against a stop bar *6* which prevents it from sliding off the roof. Where no stop bar is available, fix the glass with clips *5* cut from galvanized roofing steel.

Now that the bottom pane is in position, apply putty along its upper edge, install clips *5*, and place another pane of glass. Then, fold the clips, backing them up from beneath to avoid breaking the glass. At least two clips should be used to hold each pane of glass. The spacing of the clips is 25 to 30 cm. They may be placed immediately near, or some distance away from, the rabbets. Each pane of glass is fixed with four springs placed along the glazing bars.

After three or four panes have been placed as described above, apply face putty so that the springs are covered completely. Take care to smooth out the putty as appropriate (Fig. 52). Strike off any surplus putty and trim the edges. Give the clips a coat of oil paint on the outside. The same treatment is also advisable for the face putty *4* when it dries out completely.

After the bay has been glazed from bottom to top, move the cat ladder to another bay and proceed in the same manner. The topmost panes should come 2 to 4 mm short of the ridge rabbet. After glazing, the ridge is covered with a strip

of roofing steel which is fixed with screws, clamps, or wire and painted over.

The clips are made by cutting a sheet of roofing steel into strips 20 mm wide and 80 to 120 mm long. Only one end is bent in advance, the other being folded on the job. The clips ensure a monolithic behaviour and extend the service life of the glass. When they are not secured with clips, glass panes vibrate violently under the action of the wind and may often break.

Figure 53 shows how to fix the glass *with both pins and putty*. Where the frames come with pins driven into the glazing bars *1*, the pins should be extracted. Place bed putty on the rabbets and press a pane of glass *2* into the putty to an even bearing. Then, insert pins *4* into the holes and drive them home with a hammer or a wood chisel. After that, apply face putty *3* and smooth it out with a putty knife.

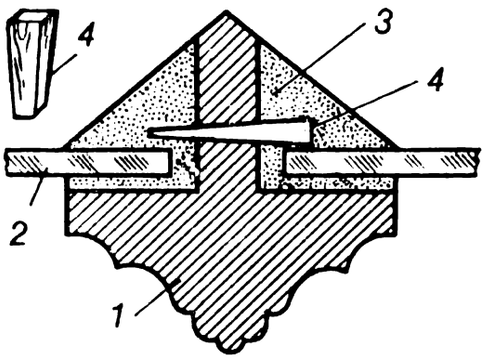


Fig. 53. Fixing the glass with pins
(*1*) glazing bar; (*2*) glass; (*3*) putty; (*4*) pin

An alternative approach is illustrated in Fig. 54. Here the glass is held in position *by clips, springs, and putty all at the same time*. As a point of departure, extract pins from glazing bars *1* (if they have been driven into the holes at the factory), place bed putty on the rabbets, and press a pane of glass *2* into the putty to an even bearing. Then, drive the pins back into the holes and put clips *4* or springs *3* on them. The free ends of the clips or springs will clamp the glass to the rabbet. The ends of the pins are sometimes peened down to prevent the clips or springs from working loose. This done, cover the pins, clips, and springs with face putty to protect them against corrosion. Strike off the bed putty that has been squeezed out of the rabbets and trim the edges.

The glass may be held in place by *wedge-operated clamps and putty* as shown in Fig. 55. Wedge-operated clamps are made of galvanized roofing steel 0.5 to 0.7 mm thick. Two types are available, namely right-hand and left-hand clamps. A wedge-operated clamp consists essentially of a wedge with a rest tooth *2* and two lugs *1*.

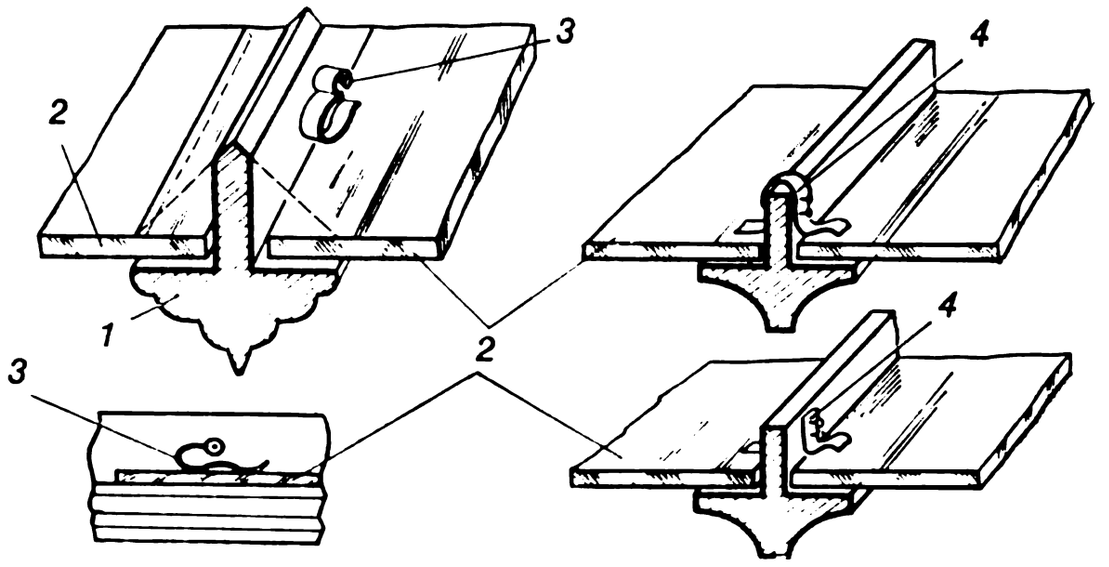


Fig. 54. Fixing the glass with springs and clips
(*1*) glazing bar; (*2*) glass; (*3*) spring; (*4*) clips

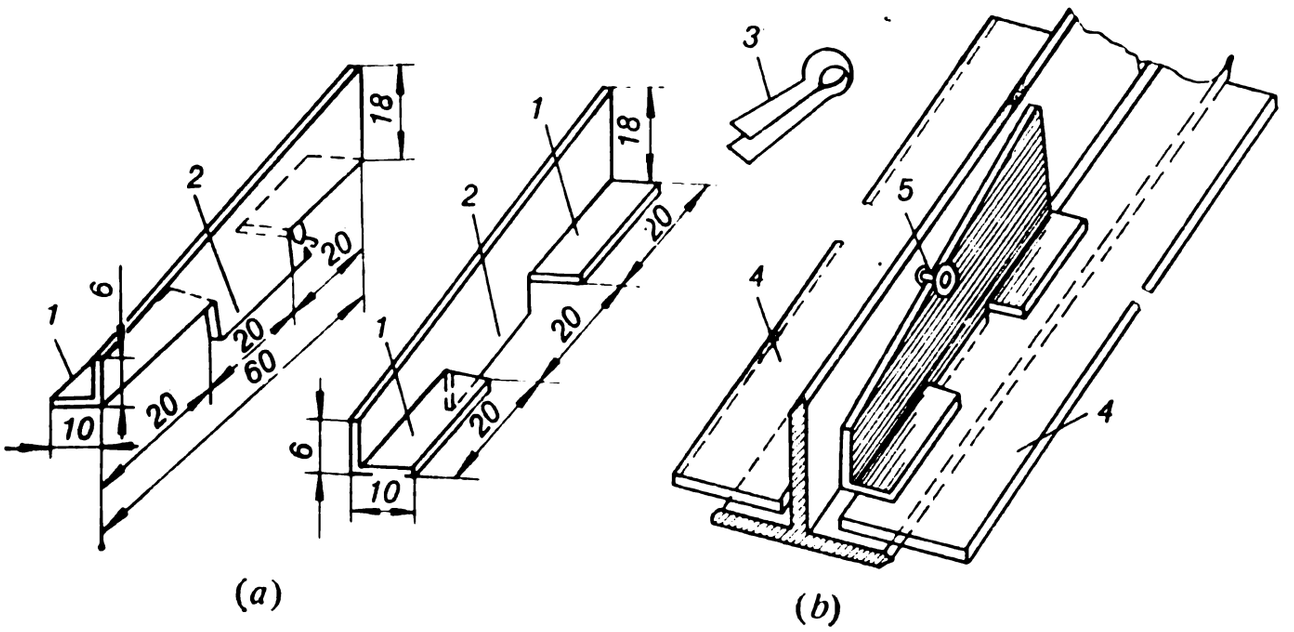


Fig. 55. Fixing the glass with wedge-operated clamps
(*a*) wedge-operated clamps; (*b*) wedge-operated clamp driven under a pin; (*1*) lug; (*2*) rest tooth; (*3*) cotter pin; (*4*) glass; (*5*) pin

To begin with, place bed putty on the rabbets and press a pane of glass *4* into the putty to an even bearing as described previously. Insert pins or cotter pins *3* into the holes in the glazing bars and force wedge-operated clamps under the pins until their rest teeth sink into the bed of putty as

far as they will go. The lugs *1* should be snug against the glass pressing it tightly to the bed putty. Peen down the ends of the pins or spread the cotter pins apart. Being forced under the pins, the clamps will hold the glass in position even when the putty has detached itself from the glazing bars.

After the wedge-operated clamps have been installed, apply face putty so that the clamps and the pins are covered completely.

Fixing the glass *with elastic gaskets and glazing beads* (Fig. 56) is carried out in much the same way as in the case of wooden sash. The rabbets and glazing beads should be given a coat of paint and cleaned from dirt and dust. The glazing beads *3* are fixed with screws *4* which should be properly greased to protect them against corrosion. The protruding parts of the gaskets *1* are cut off. The joints between the glazing bead and the glazing bar or between the bead and the glass *2* may be filled with putty or a polysulphide (Thiokol) sealant. A bed of putty is necessary to prevent the glass from breaking.

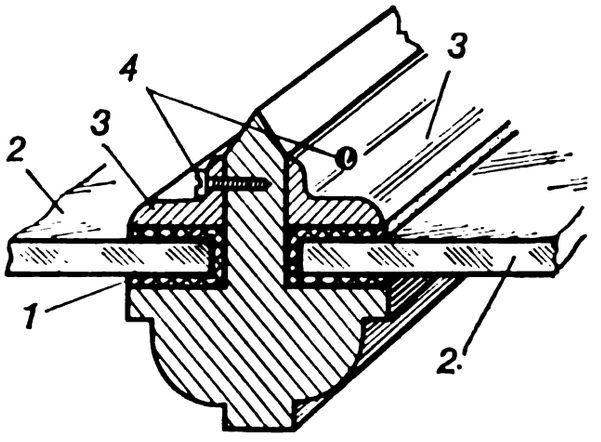


Fig. 56. Fixing the glass in a metal frame with elastic gaskets and glazing beads fastened by screws (*1*) elastic gasket; (*2*) glass; (*3*) glazing bead; (*4*) screws

Reinforced concrete frames are glazed similarly to metal frames. The glass may be held in position by pins, springs, clips, glazing beads, or wedge-operated clamps. Appropriate holes are left in the frames in the course of casting. Glazing beads of metal or wood are fixed by wood screws. For this purpose, wooden plugs are driven into the holes during manufacture in such a way that the plugs are unable to fall out on shrinking.

Glazing Greenhouses. Greenhouses may have pitched, shed, or arch roofs. The roofs consist of bearing elements and glazing bars on which glass is placed. The glazing bars

may be made of metal or wood. All-wood greenhouses are also common.

The glazing bars are spaced a short distance apart, so undersize glass and remnants may be used. Where large sheets are to be cut into smaller panes, the cutting should be carefully planned to make the most of the available material. All metal and wooden elements should be allowed to dry and given a coat of drying oil and two coats of paint before glazing.

Greenhouses may also be assembled from individual frames joined into a space structure. Here, too, the spacing of the glazing bars is small.

Greenhouses are glazed with sheet glass 4 to 6 mm thick. It is hardly advisable to use thicker glass, because it tends to break due to a considerable temperature difference. The glass is secured in place with glazier's putty or bitumen-based compounds.

Before it is set in the rabbets, the glass should be cut to size, wiped clean, and allowed to dry. Face putty alone is generally used.

28. Placing Heat-Absorbing and Other Types of Glass

Intercepting up to 75% of thermal rays, heat-absorbing glass is widely used in buildings where considerable variations in temperature may take place. When placing the glass, it should be remembered that it expands on heating and may crack if it fits the rabbet tightly. To avoid this, a sufficient gap should be left between the edges of the heat-absorbing glass and the rabbets. Ordinary glazier's putty is unsuitable for fixing heat-absorbing glass. Here, use is generally made of elastic glazing compounds which do not dry out for many years on end. Lights of glass larger than 1 500 × 1 800 mm are fixed in place by rubber gaskets or pads.

The glazing procedure for heat-absorbing, wire, figured, frosted, sun-protective, uviol, diffusing, and coloured glass is essentially the same as for ordinary sheet glass.

X-ray glass is set in special glazing compounds contain-

ing suitable fillers which do not transmit X-rays. Rubber gaskets are also used on some occasions, in which case the frame is covered with a sheet of lead around the periphery.

29. Safety Precautions

Wear overalls, safety goggles, and gloves when cleaning the sash or other structures to be glazed.

Keep your tools in boxes or bags so that you will not drop them accidentally when moving from place to place or working on a scaffold.

Wear a safety belt when you work high above the ground. Be sure to attach it to a reliable structure.

Remember that safety belts must be tested every six months under a static load of 225 kg for 5 min. They must have a tag in which the belt number and the date tested are stated.

Take care to put up a fence and to post warning signs around all areas of possible danger. When glazing roof lights, set up a protective platform below.

Beware of sharp edges when applying bed putty to rabbets.

When pressing the glass into bed putty, be sure that your hands rest upon the pane right against the rabbet. Otherwise, you may break it.

Cut rubber gaskets and similar parts on a firm backing only. Move the knife away from yourself when cutting off gasket portions protruding above the rabbet.

Install scaffolds, platforms, and ladders on a firm base only.

Avoid leaning ladders directly against the panes or glazing bars. Make sure that cat ladders are reliably hooked over the ridge.

Before puttying rabbets, clean the tables or benches from glass and other debris with a brush. Wear safety goggles as you do so. Make sure that the edges of your putty knives and wood chisels are safely blunt and free from dirt and rust.

Clean your overalls from dirt and dust after work every day.

Chapter Eight

Job Layout

30. General

Depending on its character, the job of glazing may be done by one or several workmen. The required number and proficiency of glaziers depend on how difficult a particular job is.

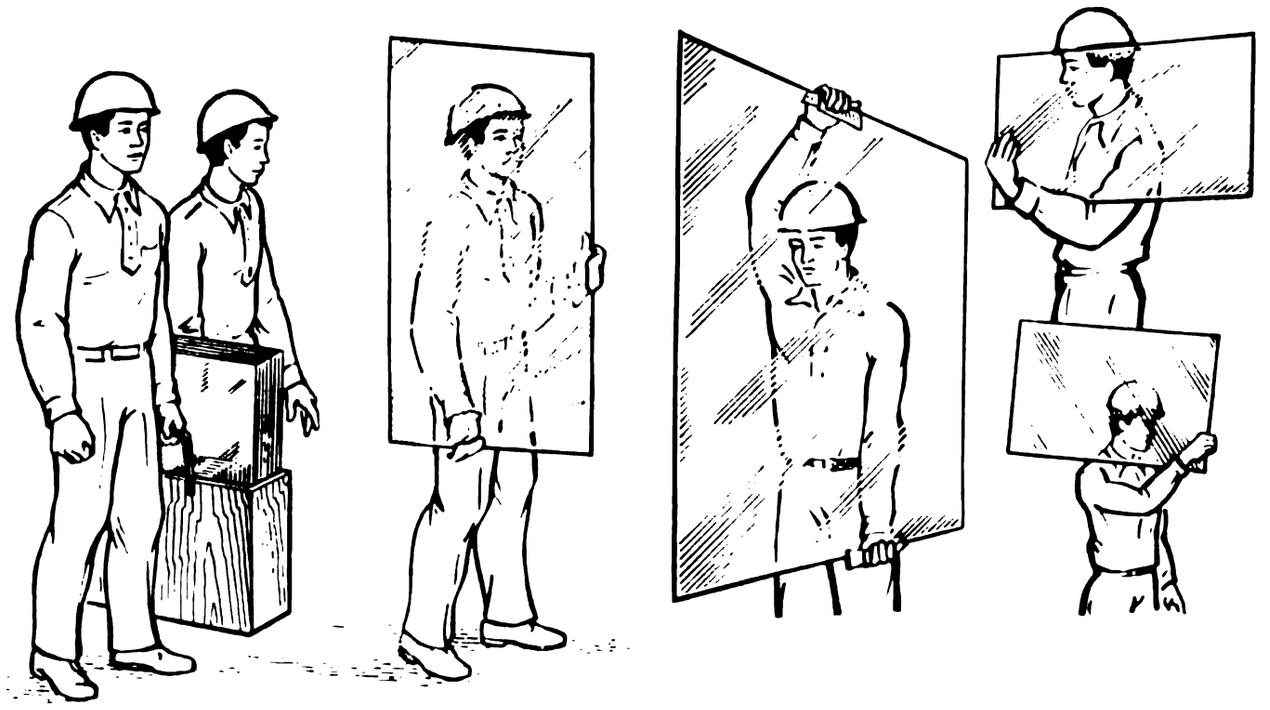


Fig. 57. Various methods of carrying glass

Putty is generally prepared by a semi-skilled workman or a labourer. Glass is cut by skilled workmen, the required proficiency rising with increasing thickness and area of the glass to be cut. Polished plated glass may be cut by foreman glaziers only.

Placing glass in the sash calls for skilled men. Here, too, the proficiency and the number of workmen required increase with increasing amount of work. For example, panes up to 1 m^2 in area may be set by one workman and those 1.5 to 2 m^2 in area, by two workmen. A gang of four usually handles the job of placing figured and polished plate glass 2 to 4.5 m^2 in area, two members of the gang being foreman glaziers. Panes 4.5 to 6 m^2 in area are set by a gang of

five (two foreman glaziers again). More workmen may be called for to handle larger panes, especially where the job is to be done high above the ground.

Sash are glazed in a permanent or makeshift workshop or directly on the job. The sash may often need some fitting and planing, for which purpose they should be unhung and sent to the workshop, especially in winter. Planing is done by joiners or carpenters, while semi-skilled men or labourers carry the sash from place to place.

The workshop should have a floor area of at least 25 m^2 and must be heated in winter. A special room should be allocated for the preparation of putty. Upon glazing, the sash are left in the workshop until the putty hardens.

Sheets and panes of glass have to be carried from place to place. This may be done while the glass is still in boxes or after it has been unpacked. In the latter case, the workmen must wear gloves. Where several sheets or panes of glass are carried at the same time, they should be tied up on four sides. Some recommended methods are shown in Fig. 57.

31. Job Layout

Panes of Glass up to 2 m^2 in Area. In the workshop, sheets of glass are cut into panes by a gang of three. A skilled man takes the glass sheets out of a box, puts them on the table, lays them out for cutting, makes the cuts, and puts the panes in different boxes according to size. Semi-skilled men or labourers bring the boxes, open them, mark the sheets, and carry the cut panes in boxes to the store-room.

Glazing of unhung sash is likewise carried out by a gang of three. A skilled man puts the sash on the table, removes the glazing beads, places bed putty on the rabbet, sets the glass, fixes the glass with sprigs, and fills the rabbet with face putty. He also removes the glazed sash from the table. Semi-skilled men or labourers unhang the sash and fetch them to the workshop for glazing. After the sash have been glazed, they carry them back to the opening and hang them on the hinges. They also bring putty and boxes with precut panes.

In a central workshop (Fig. 58), sash are glazed by a gang of four. Two skilled men lay out the glass for cutting, make

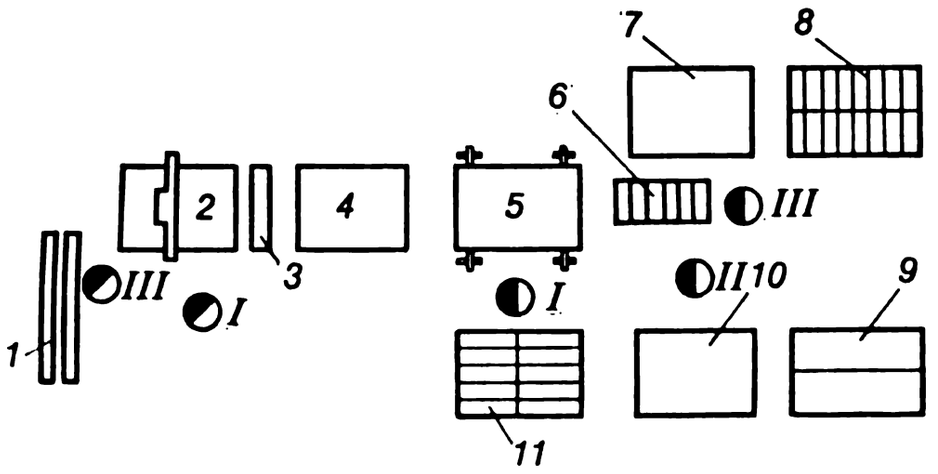


Fig. 58. Typical layout of a central workshop
(*1*) box with glass; (*2*) cutting table; (*3*) waste box; (*4*) table or rack for cut panes; (*5*) bench for setting glass in sash; (*6*) stack of sash prepared for glazing; (*7*) bench for preparing sash for glazing (cleaning of rabbets, bedding); (*8*) stack of sash to be prepared for glazing; (*9*) table for putty, pins, and glazing beads; (*10*) table for glass cleaning; (*11*) stack of finished sash; *I*—labourer's work place; *II*—skilled man's work place; *III*—labourer's work place

the cuts, set the glass in the sash, and fix it as appropriate. Two semi-skilled men or labourers open the boxes, bring the sash, and carry away the glazed sash.

On the job, sash are glazed by a gang of four. Two skilled men remove glazing beads or metal angles, clean the rabbets, apply glazier's putty or mastic, set the panes, and fix the glass with the glazing beads. Two semi-skilled men or labourers fetch the materials and move the scaffolds, ladders, or cradles.

Glazing by Flow-Line Methods. *Method 1.* With this approach, a workshop is set up where it will be easy of access to vehicles bringing in the materials. The proficiency and number of workmen in teams and gangs depend on the amount of work to be done, the completion date, the season of the year, and so on.

Sheets are cut into panes by foreman glaziers in the central shop. The panes are placed on shelves or racks and their size is indicated as appropriate.

Putty or glazing compounds are prepared by skilled or semi-skilled men.

Each gang consists of one skilled man and two semi-skilled men or labourers. The skilled man (who is the gang

leader) trims the precut panes to size and beds the glass in the rabbets. The semi-skilled men or labourers clean the rabbets from dirt and dust, apply bed putty, fix the glass in the sash, and place face putty. Where glazing beads are used instead of face putty, the operations are essentially the same.

Method 2. Here, the first step is to inspect and to measure the sash to be glazed. Then, glass sheets of optimum size are ordered to keep the wastes to a minimum.

During the warm seasons, the glass is cut in a workshop and set in the sash directly on the job. For this purpose, a special gang is formed to cut the glass in a central or makeshift shop. Cutting the glass on the job is obviously a poorer choice, because large sheets of glass would have to be delivered up the scaffold and wastes would have to be sent back. Handling glass in this manner would inevitably entail breakage and injuries. Also, wastes are far easier to dispose of in the shop, and smaller panes are much safer to carry up the scaffold. Last but not least, centralized cutting will markedly improve labour productivity and help to prevent a good deal of hanging about the site.

In winter, the sash should be glazed in a heated room. So, they have to be carried back and forth.

A typical cutting shop is equipped with three tables to cut glass, boxes to collect wastes, and shelves or racks to store panes of glass. Glass is cut to templates with glazier's diamonds or wheel-type cutters.

In the course of glazing, the sash have to be unhung and hung back. For this reason, they should be checked in advance by a carpenter or joiner and properly fitted if necessary.

Gangs engaged in placing the glass in the sash are equipped with four lightweight trestles 800 to 900 mm high and 1 500 mm long. Two or three planed boards up to 2 000 mm long are placed on two such trestles to make up tables for the sash.

The gang leader is usually a foreman glazier.

Large jobs are handled by a team consisting of four gangs. *The first gang* includes a skilled man and a semi-skilled man or a labourer. They prepare putty and place it in tanks or boxes.

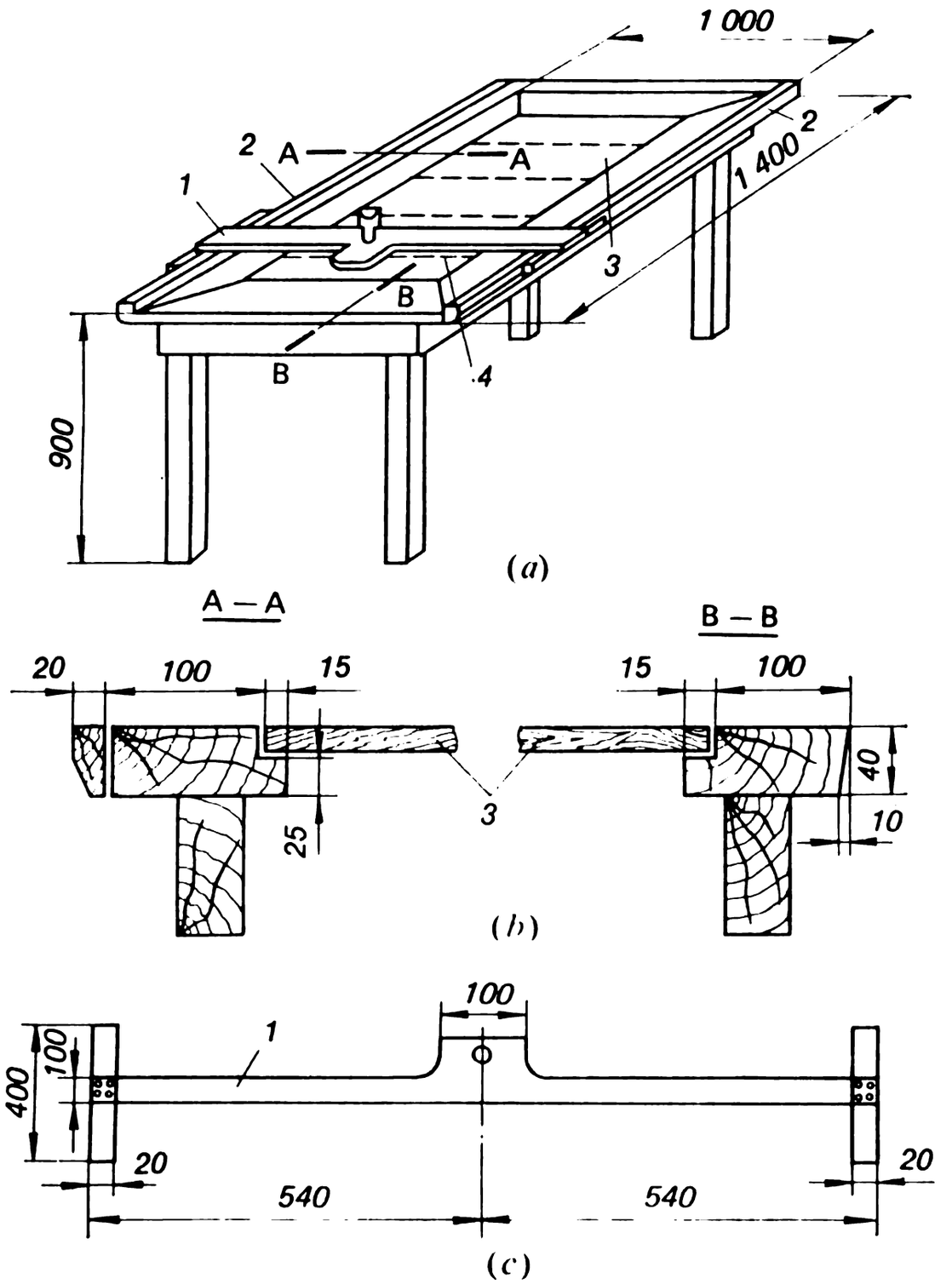


Fig. 59. Glass-cutting table with a straightedge
(*a*) table; (*b*) table components; (*c*) straightedge; (*1*) straightedge; (*2*) side bar; (*3*) plywood; (*4*) marks for cutting

The second gang consists of two skilled men and two semi-skilled men or labourers. The skilled men cut glass sheets and grade the panes according to size, placing them on racks. The semi-skilled men or labourers do all odd jobs. Sometimes, they may cut small panes of glass.

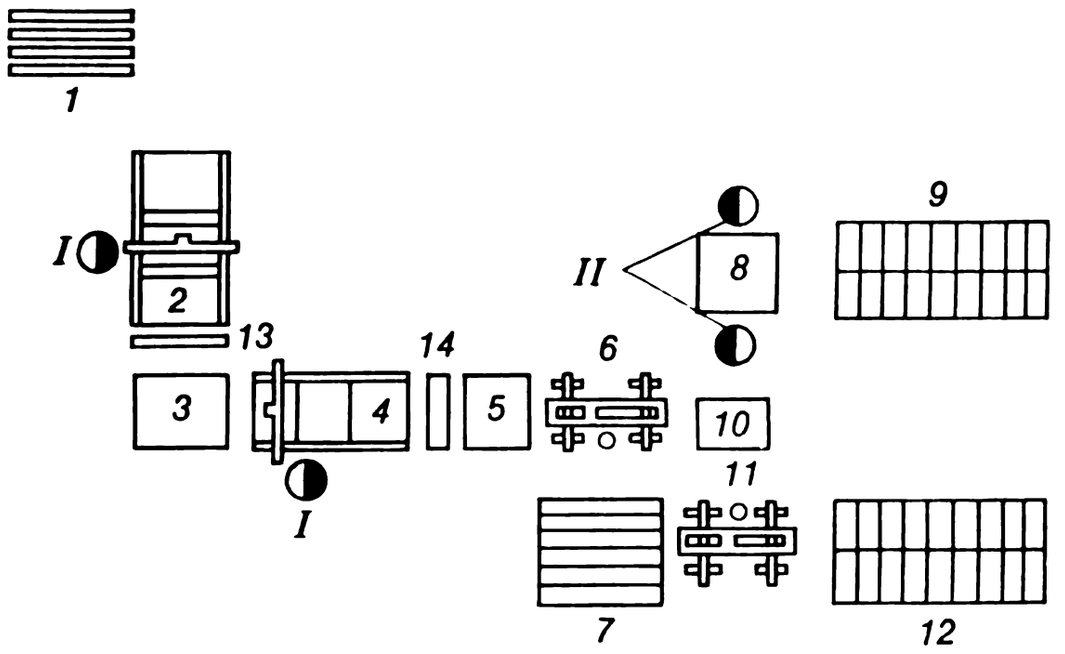


Fig. 60 Typical layout of a central workshop
(*1*) box for glass; (*2*) table with top sloping at 15° for cutting large-size glass; (*3*) bench for cutting small glass; (*4*) bench for cutting along transverse marks; (*5*) table for glass; (*6*) trestled table for placing glass and driving pins; (*7*) stack of sash with puttied rabbets; (*8*) table for applying bed putty; (*9*) stack of glazed sash; (*10*) table for putty; (*11*) trestled table for placing bed putty; (*12*) stack of sash to be glazed; (*13*), (*14*) waste boxes; *I*—foreman glaziers; *II*—skilled men

The third and fourt gangs place the glass in the sash. Each gang consists of one skilled man and three semi-skilled men or labourers.

The foreman glazier plans the cutting of glass and, if necessary, helps his teammates.

Method 3. With this approach, a central workshop is set up at or off the site, or makeshift shops are arranged on each floor of the building. When it is set up at the site, the workshop should be located close to a hoisting plant. Glass sheets are cut into panes on a special table (Fig. 59*a*). The top of the table is given the shape of the sash. A sheet of plywood *3* is placed in the sash flush with the top of the rabbet. It is 15 mm thick and will not warp when glass sheets are put on it. Marks *4* are scribed on either side of the plywood sheet to indicate the desired pane size. Wooden bars *2* are nailed to the table top on three sides (one across and two along the table). They project by at most 2 mm above the sash. One of the shorter sides of the table is left

open — the scored glass is broken over its edge. The bars give support to a movable straightedge *1* (Fig. 59*c*) along which a glass cutter slides. Two guides are nailed at the ends of the straightedge to prevent skewness.

A typical workshop (Fig. 60) is equipped with two such tables of different size, several ordinary tables, and trestles. The top of the tables on which glass is cut are given a slope of 15° towards the open side to facilitate the movement of the sheets.

The team consists of three gangs. The first gang includes a skilled joiner and a joiner's labourer who unhang the sash, bring them to the workshop, fit the mating parts, carry the sash back to the job, and hang them again on the frames.

The second gang consists of two foreman glaziers who measure and cut the glass.

The third gang consists of four semi-skilled men or labourers who set the glass in the sash. One of them takes a sash from a stack *12*, places it on trestles *11*, fills the rabbet with putty taken from a table *10*, and puts the prepared sash on a stack *7*. Another labourer takes a sash from the stack *7*, places it on trestles *6*, takes a pane of glass from a table *5*, presses it into the bed putty, and fixes the glass with sprigs. A third workman takes the glazed sash from the trestles *6*, puts it on a table *8*, and places face putty. Finally, the fourth workman takes the finished sash from the table *8*, wipes it clean on both sides, and puts it on a stack *9*.

Chapter Nine

Placing Plate Glass

32. General

Plate glass or polished plate glass, as it is also referred to, is used to glaze show-cases, shop windows, and windows in exhibition halls, cafés, restaurants, airports, railway stations, and various public and industrial buildings. It also finds application in multi-tier and continuous windows having aluminium sash and frames.

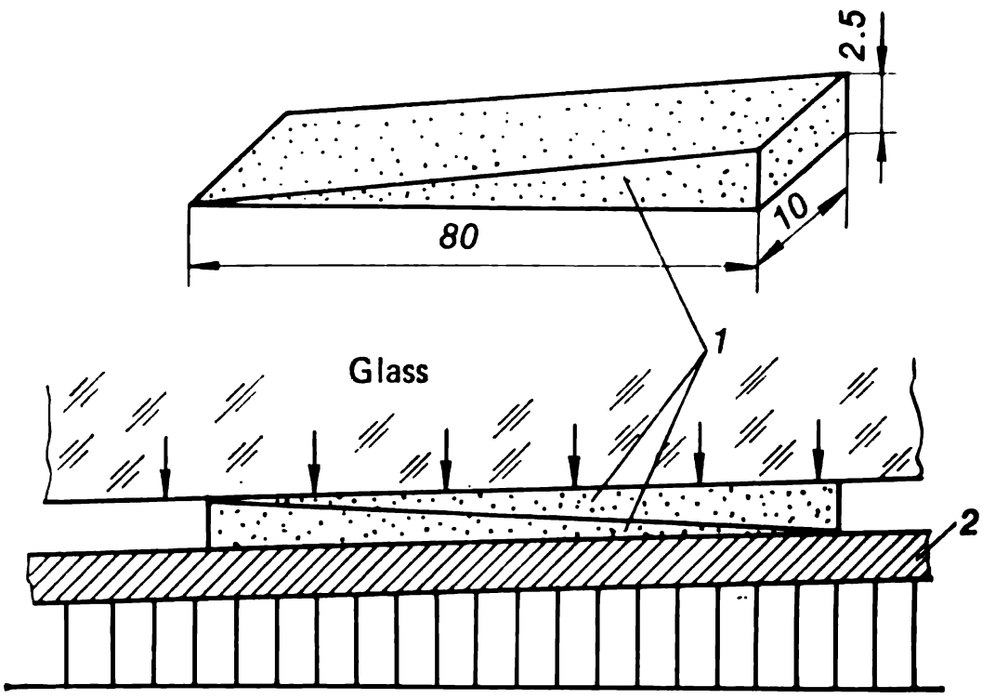


Fig. 61. Folding-wedge pad placed on an aluminium-alloy levelling pad
(*1*) pair of folding wedges; (*2*) levelling pad of aluminium alloy

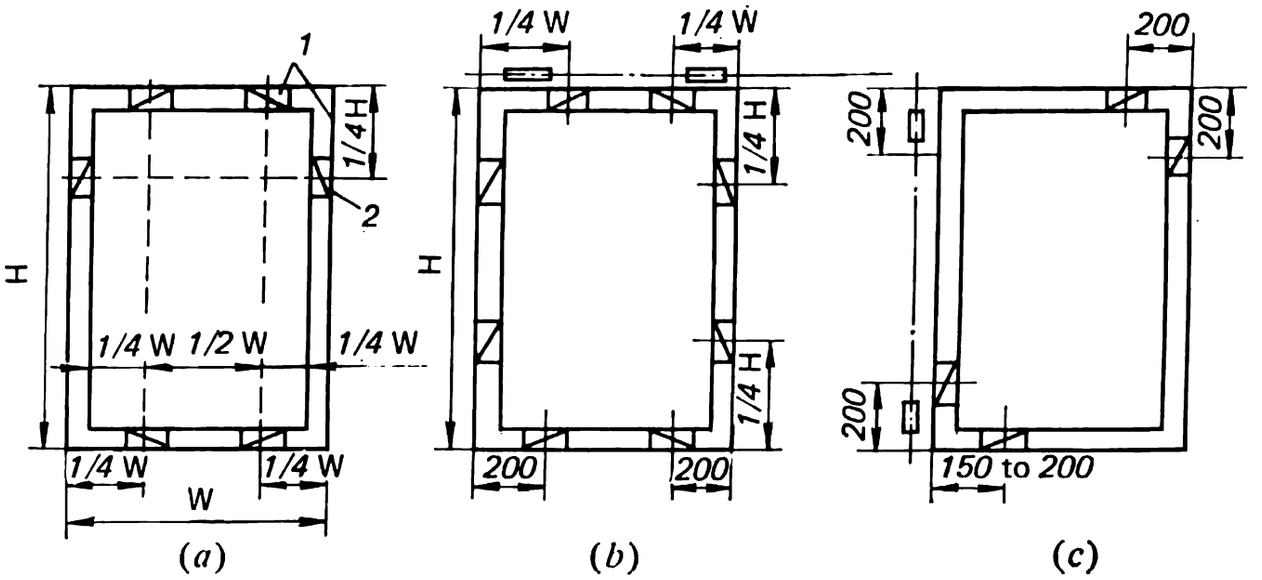


Fig. 62. Distribution of folding-wedge pads around the periphery of frames
(*a*) fixed frame; (*b*) top-pivoted frame; (*c*) side-pivoted frame; (*1*) folding-wedge pads; (*2*) frame side

Large windows are glazed with one or two thicknesses of glass with an air space between them. The glass plates used for the purpose are 6 to 10 mm thick. The frames are made of metal or wood. As a rule, the glass is set in sealing gaskets and fixed with glazing strips. Putty or glazing

compounds are used to a far lesser extent than with window glass. The edges of the glass plates should not be in contact with the metal frames. If the bottom rabbet has an uneven surface, it is levelled up by means of aluminium-alloy pads *2* (Fig. 61). To prevent the glass from breaking, use is made of wedge-shaped rubber pads *1* which are 80 mm long, 10 mm wide, and 2.5 mm high at the thicker end. The rubber pads are used in pairs in a folding-wedge fashion as shown in the figure.

The folding-wedge pads *1* (Fig. 62) are installed in both operating and fixed frames, either at the bottom only or around the periphery. For example, in the fixed frame of Fig. 62*a*, two pairs of pads are placed at the bottom at fourth points. Where the glass is 4 m wide, the pads are placed within 1 m of the frame sides *2*.

Windows of modern construction generally have two removable glazing strips. In some types, however, one of the strips may be removable, and the other fixed. In double-glazed windows, the outer plate is fixed from the outside and the inner plate, from the inside.

33. Handling of Plate Glass

Plate glass is delivered to the site by vehicles, packed in boxes. The boxes should be placed in an upright position on a firm base. Broken fragments are taken out piece by piece. In doing so, the workmen must wear gloves. Wood chips and boards are removed, and two wooden blocks at least 30 cm wide each are placed near the box at fourth points.

When taking it out of the box, avoid inclining the glass by more than 15°. Use a bench of suitable size to cut the plates. Before laying out the glass for cutting, measure the distance between the rabbets and make sure that the rails and stiles meet at right angles, so that the plate may have the desired shape and size. The width and length of the cut plate with the gaskets on should be by 4 or 5 mm shorter than the respective distance between the rabbets.

It will be a good plan to make two parallel cuts spaced 2 or 3 mm apart to prevent the glass from spontaneous cracking when the desired plate is broken off. Plate glass is cut with glazier's diamonds or wheel-type cutters.

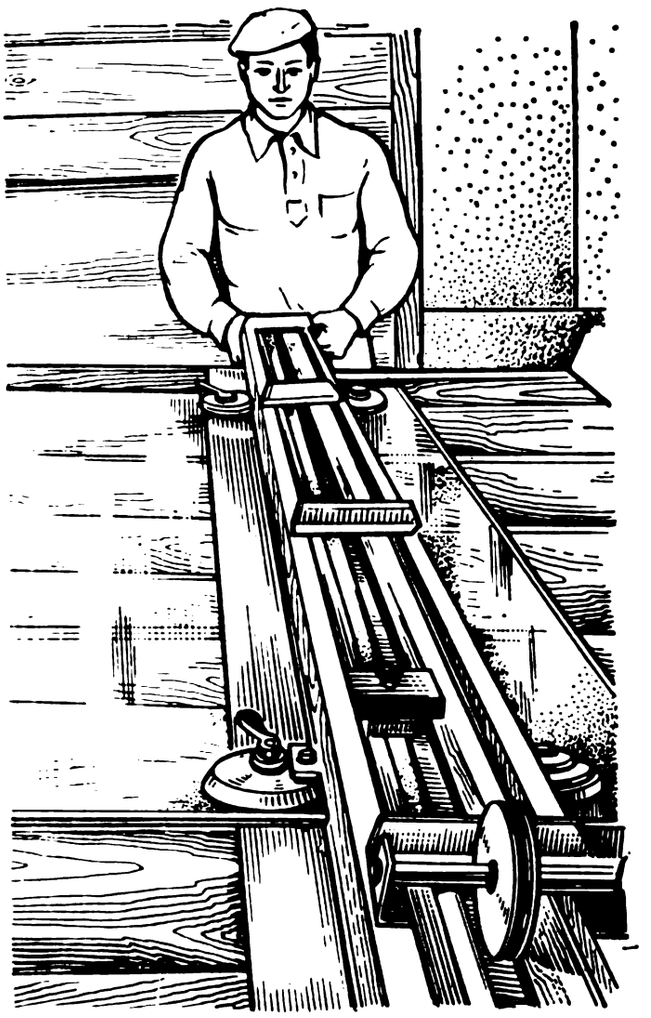


Fig. 63. Cutting glass with a remotely controlled rig

Fig. 64. Handling glass with suckers

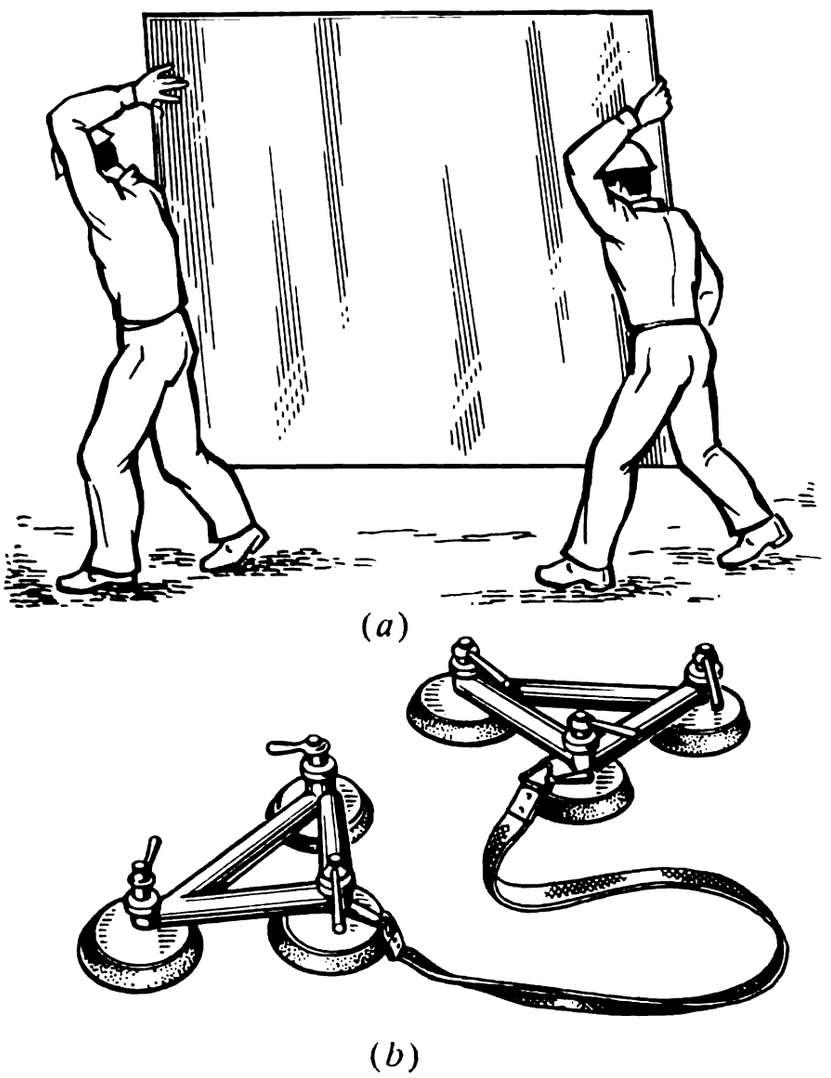


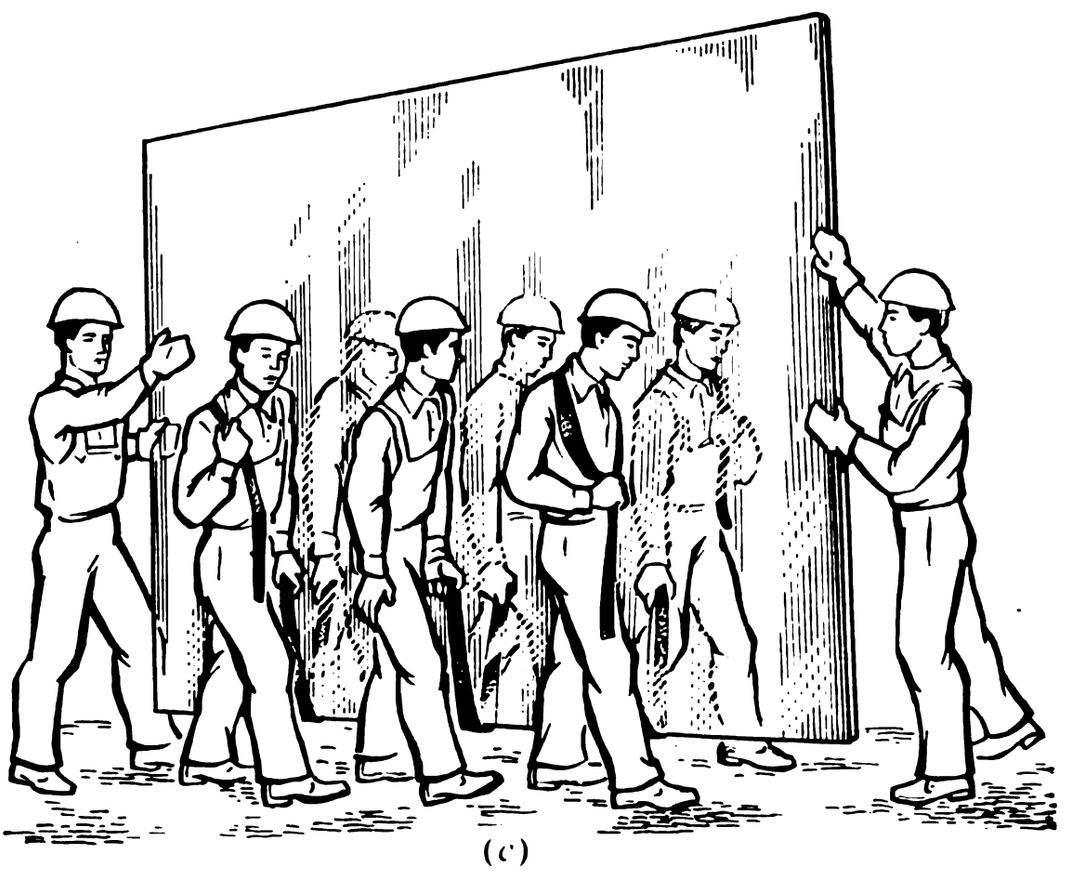
Fig. 65. Carrying glass
(*a*) by hand; (*b*) with suckers;

Figure 63 shows a remotely controlled cutting rig. The rig is firmly held to the glass by one-cup suckers, two suckers being provided on either side of the cut. A carriage with cutters is pulled along fixed straightedges by a rope.

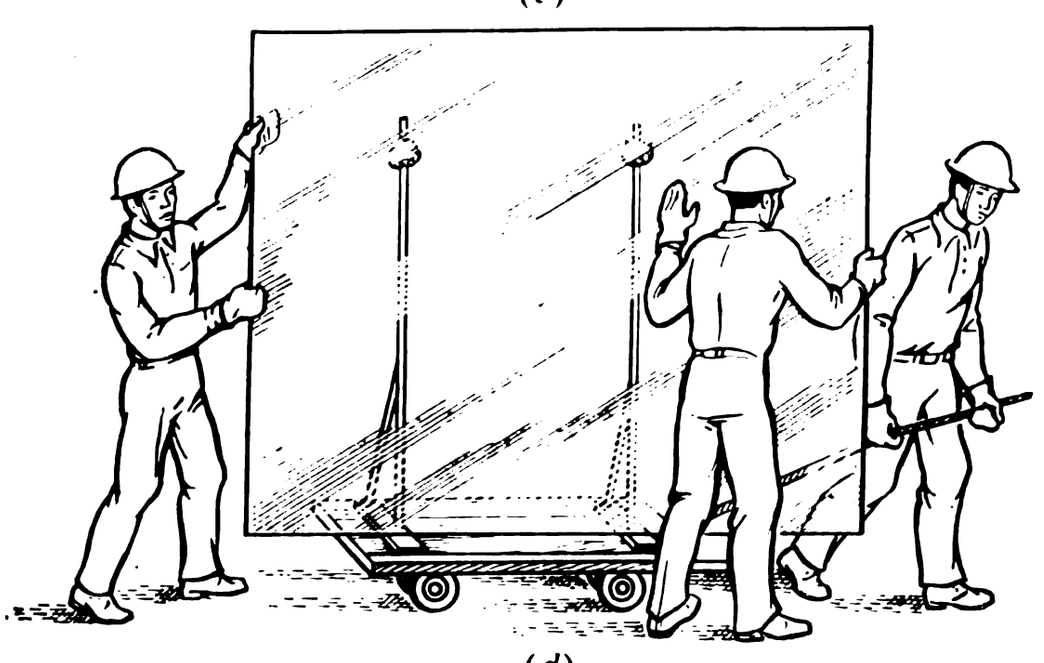
Plates of glass can conveniently be picked up, carried, or otherwise handled with three-cup suckers (Fig. 64).

In central shops, glass is cut by gangs of five workmen, including a foreman glazier, a skilled man, and three semi-skilled men or labourers.

A similar gang is set up for placing the glass in the frames. Sometimes, two more semi-skilled men or labourers may be added where the glass is large or where it is to be set high above the ground. Glass should be carried from place to place with great care. Small plates of glass may be carried by hand by two workmen (Fig. 65*a*). For larger



(*c*)



(*d*)

Fig. 65. (continued)
(*c*) with straps; (*d*) on a trolley

plates, use is made of suckers and straps (Fig. 65*b*) or straps alone (Fig. 65*c*). Glass may also be moved on a trolley (Fig. 65*d*) with rubber wheels and two wood-block pads. Where suckers are used for handling glass, the straps are passed

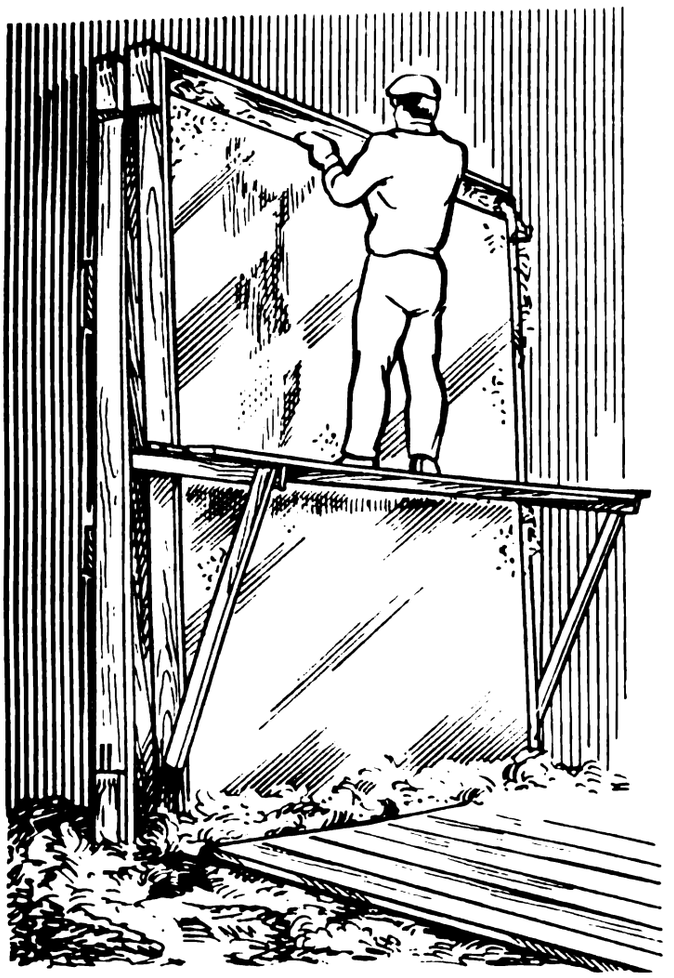


Fig. 66. Scaffold boards placed on braced brackets

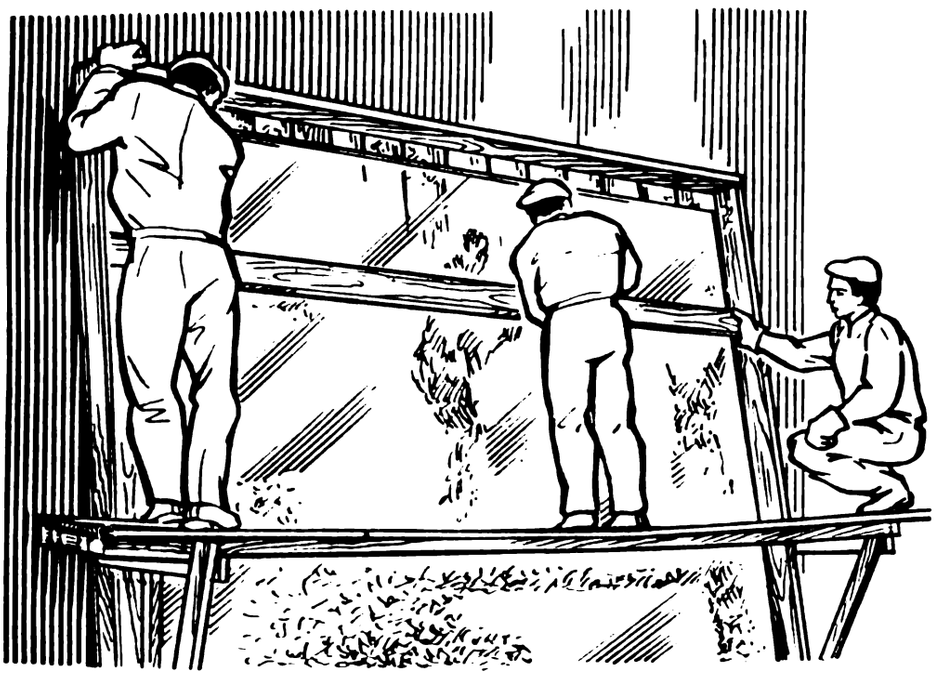


Fig. 67. Cutting plate glass in a box

under the plate and attached to the suckers on either side of the glass. The plate is picked up by sucker's handles, the straps being used for safety should the cups slip.

In doing small and especially repair jobs where no more than one or two plates are to be set, cutting tables need not be brought to the frame. Instead, the glass may be cut directly in the box by a foreman glazier.

For this purpose, open the box and take the cover away or use it as a working platform. In the latter case, take care to clinch all the nails. Then, erect a trestled scaffold or nail braced brackets to the box sides and place scaffold boards on them as shown in Fig. 66. Wipe the glass clean either throughout or as far as the cut to be made.

Next, lay out the glass for cutting. Tell two labourers to climb up the scaffold and to hold a straightedge along the mark as you cut the glass (Fig. 67). Tilt the glass towards yourself so that it may be tapped on the other side to facilitate breaking. Insert a board or straightedge under the plate with the edge right under the cut, and break off the cut piece.

After it has been thus cut to size, the glass is taken out of the box. If suckers are available, the plate is cleaned from dirt and dust within 50 or 60 cm of the bottom edge, and two suckers are placed on the clean surface. The working platform is removed. Two workmen climb up the box and set the glass in an upright position. Two other workmen on the ground take the suckers by the handles with one hand, lift the glass slightly while holding it with the other hand, take the plate out of the box, and put it on wooden pads laid on the ground.

Where suckers are not available, the following procedure may be recommended. To begin with, the working platform is removed, and two labourers take the glass on either side and gradually set it upright. Then, they slightly lift the glass and pull it carefully until it comes off the box bottom and finds itself on the wooden pads. After that, straps are passed under the glass. In doing so, each labourer grips the strap with one hand and holds the glass with the other hand, so that the plate remains upright when it is carried to the job. On the job, the glass is put on pads.

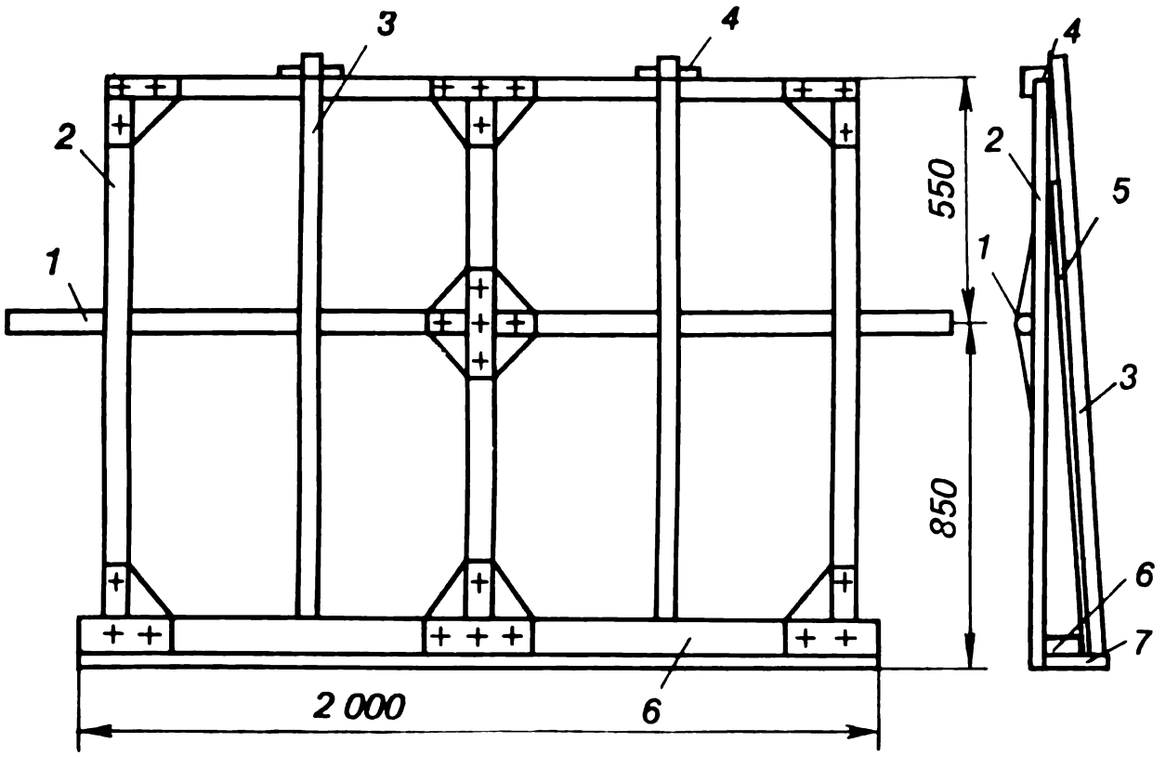


Fig. 68. Frame for carrying plate glass
(1) handle; *(2)* frame; *(3)* lock strip; *(4)* clamp; *(5)* glass; *(6)* side batten; *(7)* supporting board

For convenience and safety, use may be made of frames. A typical frame is shown in Fig. 68. It has a supporting board *7* on which the glass is placed and a side batten *6* which is slightly inclined and prevents the glass from contact with the back of the frame. The glass is held in place by lock strips *3* which are fixed at the top with clamps *4*. Fixed reliably in the frame, the glass can quickly be placed in a horizontal position, so that its edges are easy to trim and gaskets may be put on them.

34. Lifting and Lowering Glass by Hand

Where no cranes are available, plate glass has to be lifted and lowered by hand, using trestles, platforms, or scaffolds to support the workmen. The supporting structures should be erected in such a way that the distance between the trestles or the poles of the scaffolds is wide enough to allow free passage of the glass plates.

The height of the working platforms should be chosen such that their top is 4 or 5 cm below the bottom rabbet of the

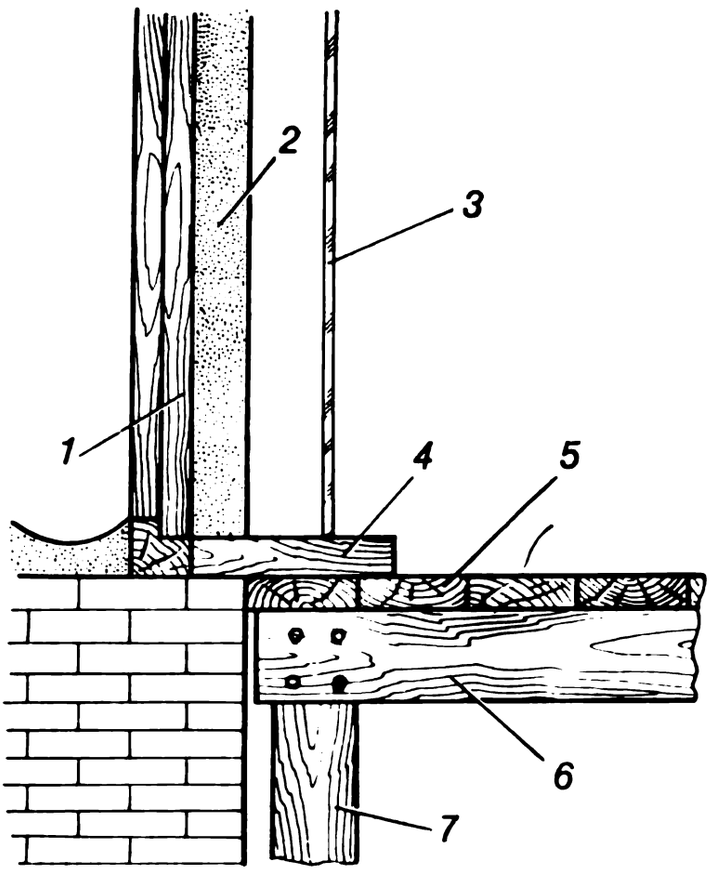


Fig. 69. Working platform for glazing windows high above the ground (*1*) rabbet; (*2*) reveal; (*3*) glass; (*4*) wooden block; (*5*) scaffold boards; (*6*) ledger; (*7*) pole

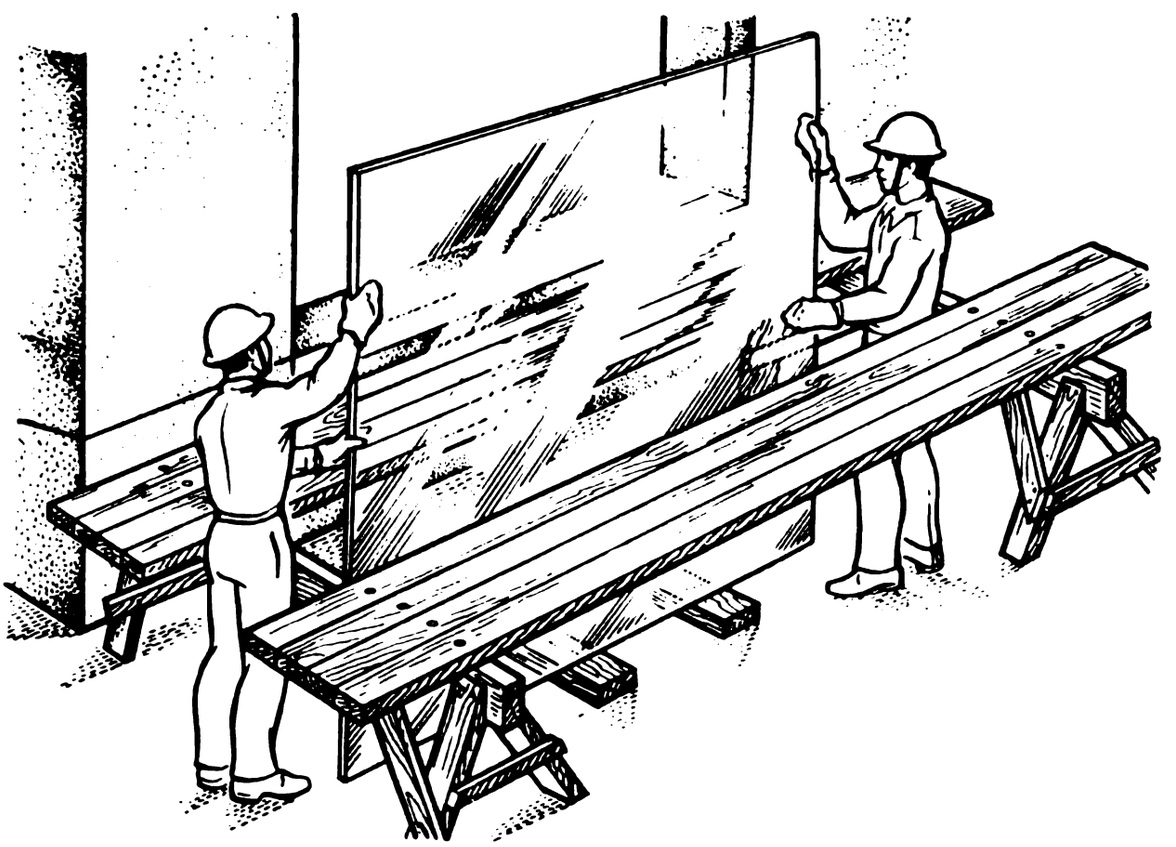


Fig. 70. Placing glass between scaffold boards

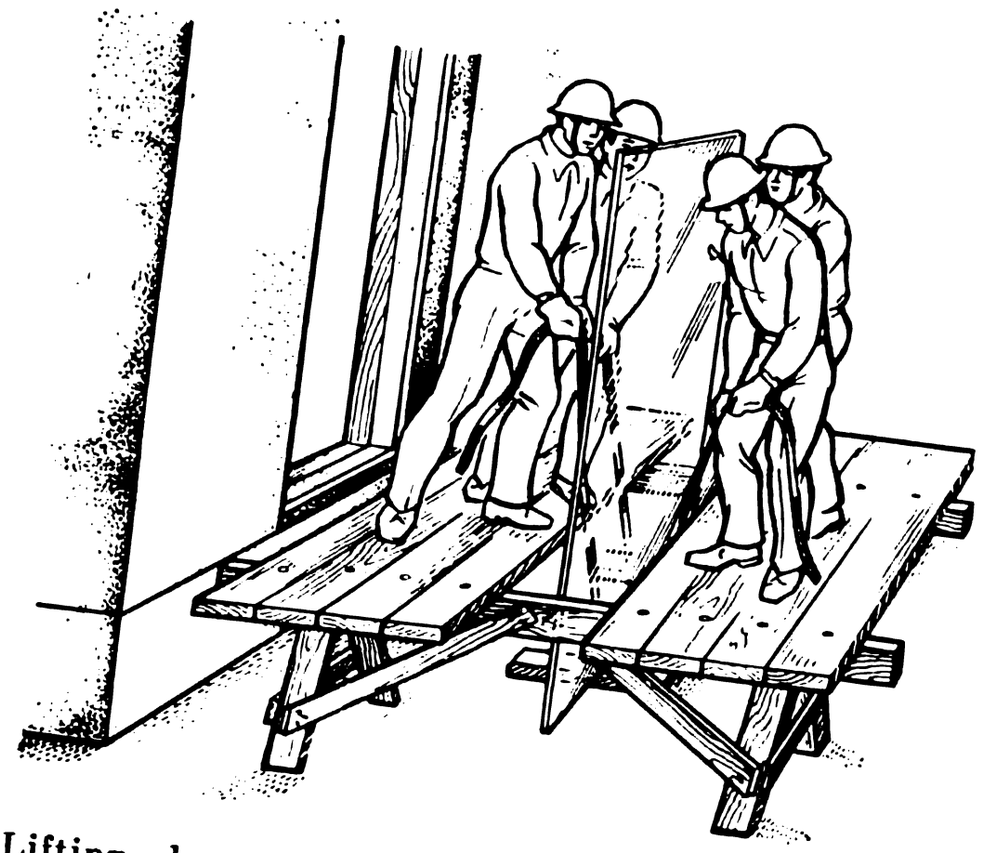


Fig. 71. Lifting glass on a platform

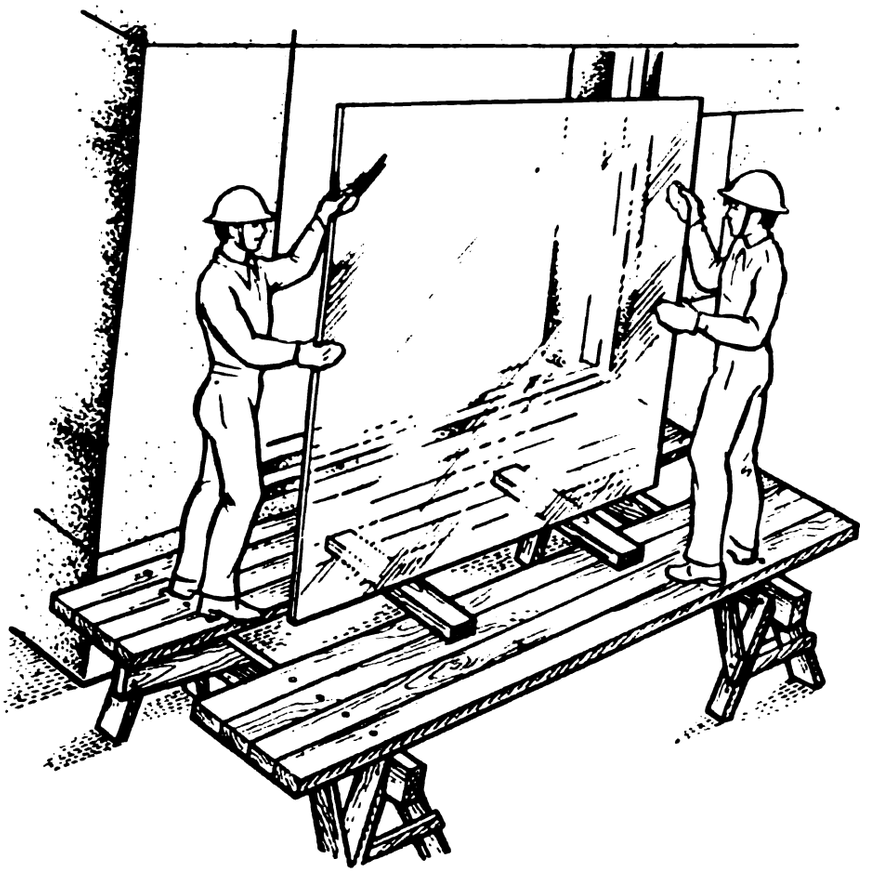


Fig. 72. Glass lifted to a platform

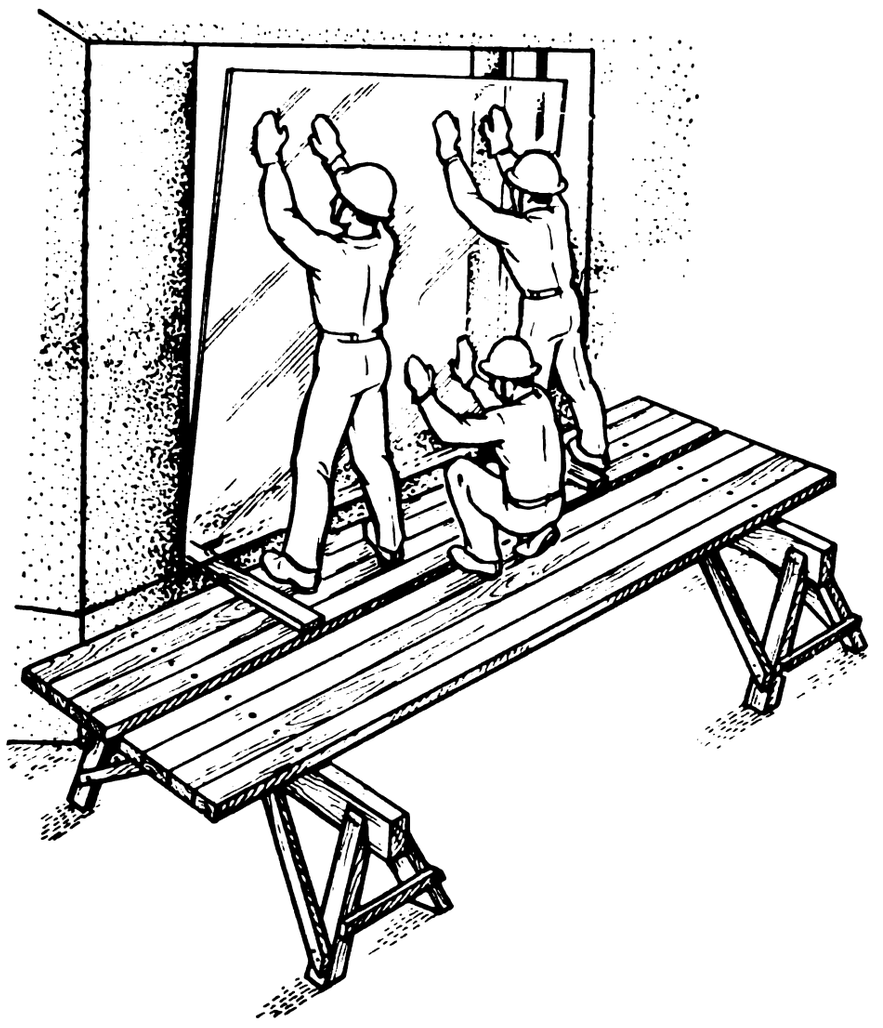


Fig. 73. Setting glass in the frame

frame. The gap is filled with wooden block *4* as shown in Fig. 69, which should lie level with the bottom rabbet.

To begin with, lay a working platform near the wall. Then, put two wooden pads on the ground, place the glass on the pads, and make another platform within 20 to 30 cm of the glass as shown in Fig. 70. The scaffold boards should be thick enough to support the workmen without sagging.

After that, pass straps under the glass and lift the plate as shown in Fig. 71, raising it above the platform so that two wooden pads may be slipped under the glass to provide support (Fig. 72).

If glazier's putty or a glazing compound is chosen to secure the glass in position, apply bed putty to the rabbet and set the glass into the rabbet, moving it along the pads as shown in Fig. 73. Where U-shaped rubber gaskets are used to seal the glass, fit them over the edges and hold them

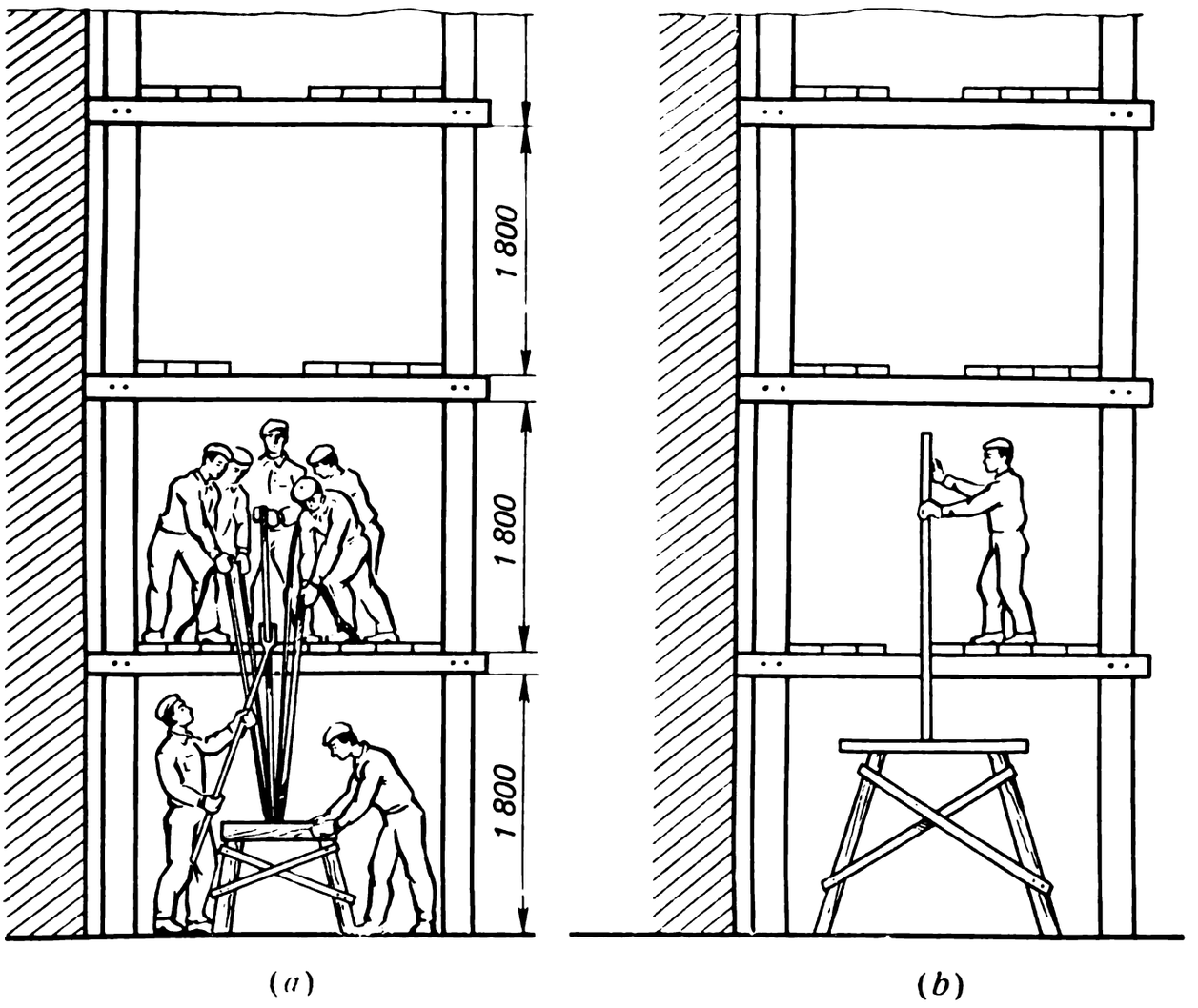
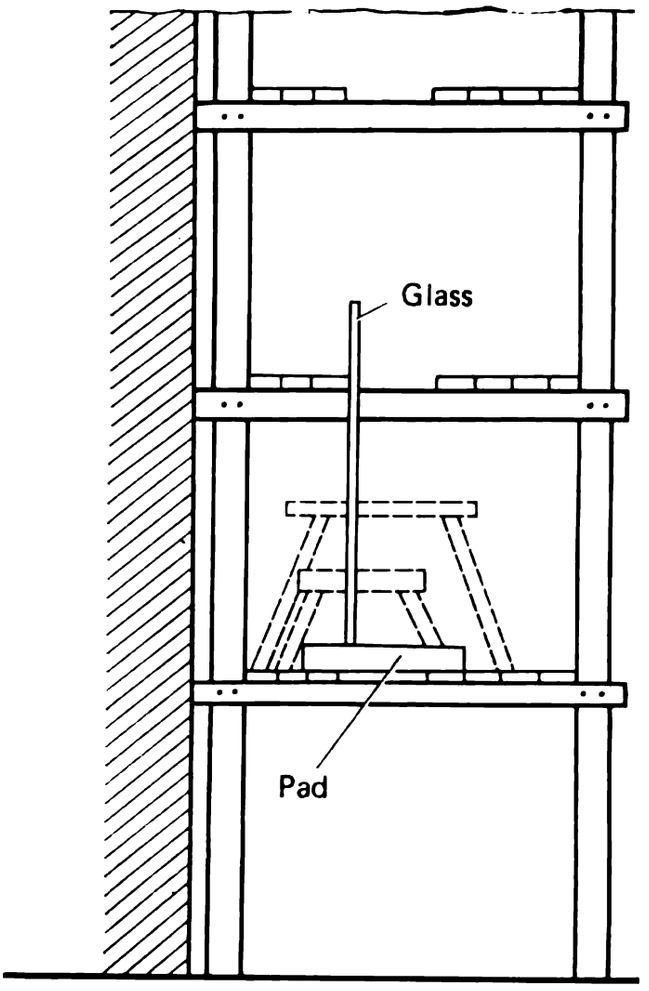


Fig. 74. Lifting glass by hand
(*a*) on the lower pair of trestles; (*b*) on the higher pair of trestles; (*c*) on the lowermost platform

in position with glue or staples driven across the joints. Then, set the glass in the frame, moving it along the pads as described above.

Second-storey windows are glazed in much the same way as first-storey windows. The gang of workmen is chosen depending on the size and mass of the glass to be handled. Firm scaffolds should be erected where no hoisting mechanisms are available. The spacing of the scaffold poles should be by 40 to 50 cm wider than the glass. The boards should not be nailed to the frame, because they will have to be removed when the glass is lifted from tier to tier.

The average tier-to-tier height of the scaffold is 1.8 m. The gang should be equipped with four wooden pads and



(*c*)

Fig. 74. (continued)

four sturdily built trestles at least 1 m long. One pair of trestles should be 60 cm high and the other, 120 cm high.

At first, the glass is carefully lifted to a height of 60 cm and placed on the lower trestles. Then, the workmen pass the straps hand-over-hand and lift the glass another 60 cm, as the other members of the gang hold the plate by the sides for better stability and slip the higher trestles under the glass. Finally, the glass is lifted from the 120-cm trestles to the lowermost platform of the scaffold (Fig. 74).

As the glass is lifted from tier to tier, the gaps in the scaffold platforms are covered with boards. Glass plates may never be left on the trestles or scaffolds after work. Where large-size windows are glazed throughout the height of the building, the work should be done from top to bottom, unless the construction of the windows calls for an alternative glazing technique. When the glass is removed from the frames, the job is done in the reversed order to avoid breaking the glass in the lower tiers. When windows are glazed in the second storey or higher, the glass below should be completely covered with boards.

35. Placing Plate Glass

Plate glass is set in the frames by means of rubber gaskets or seals of various shape and size. Glazier's putty and glazing compounds are usually reserved for small plates.

Here, too, the bottom edge of the glass is placed on a rubber strip.

Depending on their construction, gaskets may be either fitted over the edges of a plate before installation or pressed into the gap between the glazing strips and the glass after the plate has been set in the frame. As an alternative, they may be placed on the frame ridges in advance, the glass being then fitted into the slots provided in the gaskets.

It should be remembered that the untrimmed, sharp edges may cut the gaskets. They tend to break off when in contact with the rabbet, thereby causing damage to the entire plate. Also, they sometimes refuse to accept the gaskets. In view of this, it is important that the sharp edges be filed off and chamfered, as it were, with a honing stick on two sides around the periphery and especially along the bottom of the plate. As you do so, be sure to wear safety goggles and gloves.

To ensure proper contact with the glass and to prevent them from working loose in the course of glazing, the gaskets should be bonded to the glass with an appropriate adhesive (in Soviet practice, this is usually done with type 88N adhesive). The adhesive may be applied either over the plate edges or on the inside of the gaskets. In the corners, the gaskets should be mitred to ensure proper contact. This may be done after the glass has been set in position or in advance. The latter method is more convenient, but the glass and the gaskets will have to be carefully measured to avoid misalignment.

Gaskets should be installed as a single unit with the joints located at the top of the glass. To prevent leaking, the gaps between the gaskets and the glass should be filled with a sealant applied by a pressure gun, putty knife, brush, or sprayer.

When it is placed into the rabbet, the glass should be held by suckers. Where no suckers are available, this may be done with straps which, however, are far less convenient. In this case, place the glass in the rabbet on wedge-shaped pads, remove the straps, and gradually extract the pads, lifting the glass by the palms of your hands on two sides.

Sometimes, the glass *2* (Fig. 75) is set in the rabbet *1* by means of wedge-shaped pads *3* nailed to the working platform.

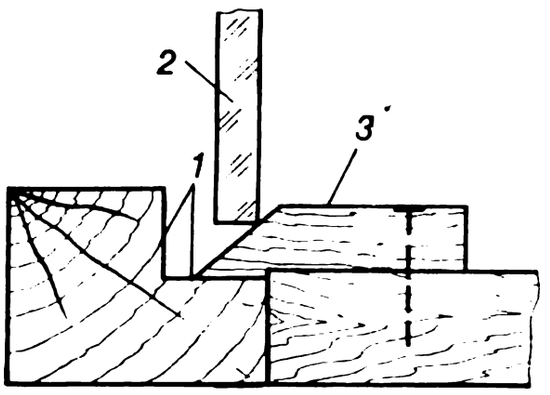


Fig. 75. Setting glass in the frame by means of wedge-shaped pads (*1*) rabbet; (*2*) glass; (*3*) wedge-shaped pad

Here, the glass slides into position along the sloping front end of the wedges. The workmen should hold the plate from both sides, lifting it slightly to ease the pressure on the bottom edge.

When it is placed in a vertical position, the glass is difficult to lift with bare hands since they keep slipping over the surface. This obstacle can easily be overcome by wearing rubber gloves.

Plates of glass are fixed in position by glazing strips which should be pressed hard to the gasket before fastening them with screws.

Let us now discuss how glass can be placed in the rabbet with the help of some Soviet-made rubber gaskets.

Setting Glass in Metal Frames with Glazing Strips. A type RP-1 rubber gasket (Fig. 76) is made of cold-resistant cellu-

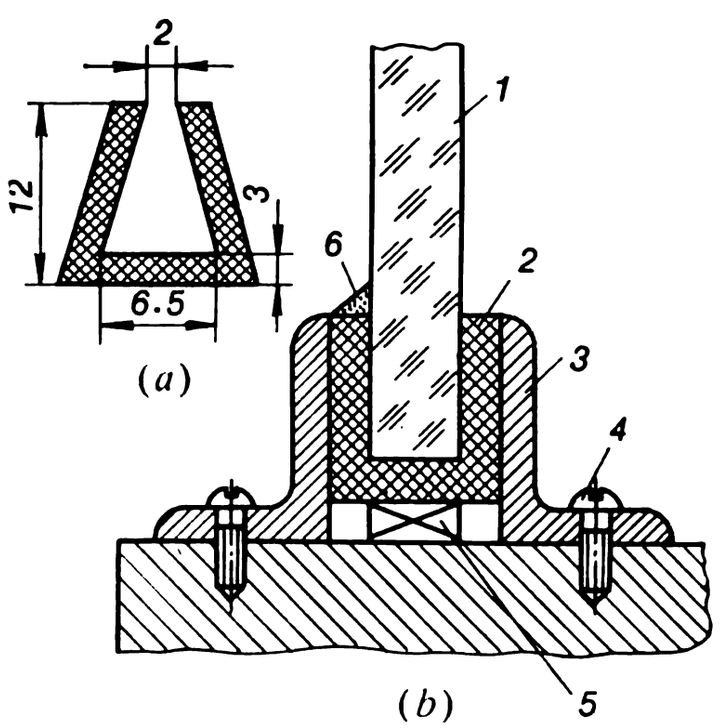


Fig. 76. Setting glass with the type RP-1 rubber gasket
(*a*) rubber gasket; (*b*) placing glass; (*1*) glass; (*2*) RP-1 gasket; (*3*) glazing strip; (*4*) screw; (*5*) folding wedges; (*6*) sealant

lar rubber and is used for fixing glass 5–5 mm thick. It has a U-shaped cross section which measures 12 mm in height, the wall thickness being 3 mm. A gap of 2 mm is left between the jaws at the top, so that the glass may fit tightly into the gasket. If they stick out of the glazing strip after installation, the jaws should be cut off level with the glazing-strip edges.

As a point of departure, remove all glazing strips *3*, measure the rabbet-to-rabbet distance, and calculate the glass plate dimensions with allowance for the gasket. Cut the desired plate of glass, file off the edges, try the gasket on, and make triangular cuts to mitre the gasket in the corners. Apply type 88N adhesive to the edges of the glass or to the inner surface of the gasket and slip the gasket over the edges, butt-jointing and fixing the ends as appropriate. Then place folding wedges *5* as required (they will be located under the gasket) and set the glass in the frame, fixing it with glazing strips held in position by screws *4*. Cut off any stick-outs with a sharp knife or chisel and cover the edge with a sealant *6*, smoothing it out into a fillet as shown in the figure.

Frames intended for glazing with type RTs-1 or RTs-5 gaskets (Fig. 77) have two removable glazing strips attached to fixing plates welded to the frame. As an alternative, one of the glazing strips may be permanently fixed. These types of gasket cannot carry any load and have to be additionally supported by folding wedges.

Using the two types together improves the tightness of the joints and simplifies the glazing and cleaning procedures.

The type RTs-1 gasket (Fig. 77*a*) has a crescent-shaped cross section 14 mm high and 8.5 mm wide. A slanted slot is provided on the outside, by which the gasket is fixed over the edge of a glazing strip. The gasket has three horns on the inside, which ensure proper contact with the glass. The type RTs-1 gasket is fixed in position after the glass has been set and secured with glazing strips.

The type RTs-5 gasket (Fig. 77*b*) is essentially a strip of rubber of serrated-edge cross section having a height of 13 mm and a width of 3.5 mm. The sharply pointed, elastic serrations hold the glass tightly in the frame. The gasket

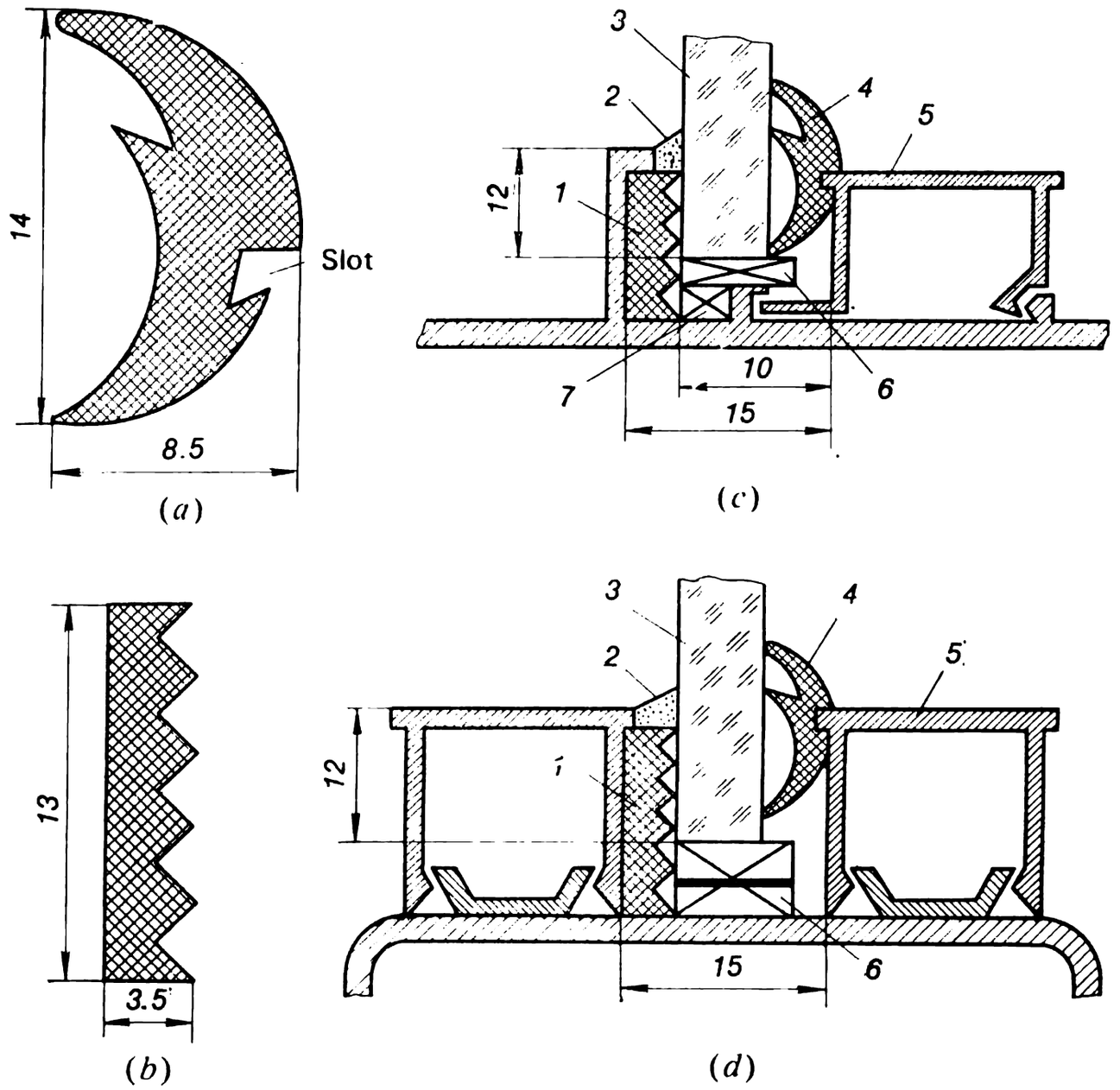


Fig. 77. Setting glass with the type RTs-1 and RTs-5 rubber gaskets (*a*) type RTs-1 rubber gasket; (*b*) type RTs-5 rubber gasket; (*c*) and (*d*) various methods of fixing glass; (*1*) type RTs-5 rubber gasket; (*2*) sealant; (*3*) glass; (*4*) type RTs-1 rubber gasket; (*5*) glazing strip; (*6*) folding wedges; (*7*) levelling pad

is bonded to the glazing strip with type 88N adhesive before the glass is placed in the frame. Both types of gasket are mitred in the corners.

To install the glass, proceed as follows. To begin with, remove the exterior glazing strips *5* around the periphery of the frame. Bond the gasket *1* to the remaining interior glazing strip or to the protruding part of the frame around the periphery. Measure the frame carefully and cut glass

plates *3* so that a gap of 3 or 4 mm is left between the glass edges and the frame and that the glass edges overlap the rabbet by at least 12 mm around the entire frame. File off the edges with a honing stick and install two pairs of folding wedges *6* at the bottom of the frame.

If necessary, insert an aluminium-alloy levelling pad *7* under the folding wedges. Place the glass in the frame and press it hard to the type RTs-5 gasket. Install folding-wedge pads around the periphery of the frame as appropriate, holding the plate in position by hand. Next, replace the exterior glazing strips. Fit the crescent-shaped gasket *4* into the space between the glass and the glazing strips, so that it is locked by the edge of the glazing strip fitted into the slot on the outside of the gasket. If the gap between the glass and the glazing strip is sufficiently narrow, an appreciable force will have to be exterted to insert the gasket. If so, it will make a very tight joint. Remember that the gasket may not be jointed at the bottom of frame. Joints are only allowed along the top or side edges of the glass (one joint per edge). The gasket should be mitred in the joints and corners for better tightness. The joints should be tightly sealed with a suitable compound. The gaps in unsealed joints (that is, before the sealant is applied) may not exceed 1 mm.

The type RTs-5 gasket should be hermetically sealed around the periphery in small frames or on three sides (along the bottom and vertical edges) in large frames. All the joints should be covered with a sealing compound. Glazed windows should be checked for leak-proofness by pouring them over for 30 min with water applied by a high-pressure fire-fighting hose.

Setting Glass in Metal Frames Without Glazing Strips. Here, the function of a load-carrying element is served by a type RU-1 hard-rubber gasket (Fig. 78). The glass is rigidly fixed in the gasket which is fitted over frame ridges in advance. The ridges are curved in shape and welded or riveted to the frame.

The gasket is 34 mm high and 24 mm wide in cross section. It has two jaws *5* (namely, a right- and a left-hand jaw) which form a groove 11 mm deep, 7 mm wide at the bottom, and 3 to 4 mm wide at the top. Two closed-section

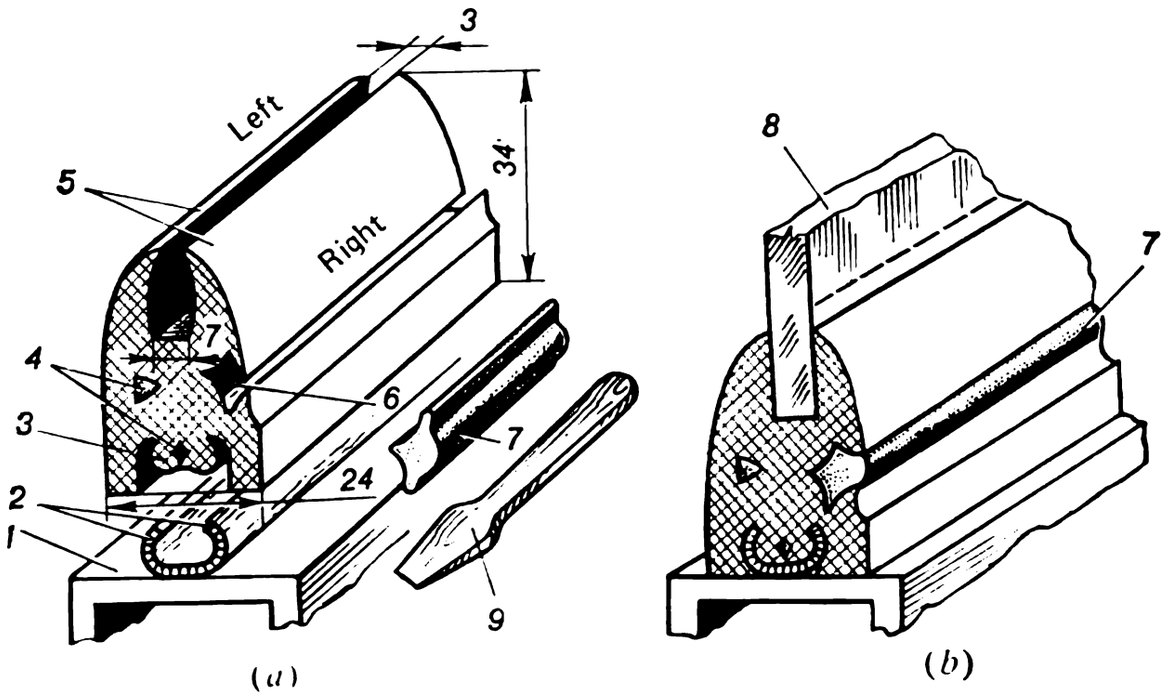


Fig. 78. Setting glass with the type RU-1 rubber gasket
(*a*) type RU-1 rubber gasket; (*b*) glass set in position; (*c*) fixing strips; (*d*) distribution of fixing strips; (*1*) frame; (*2*) ridges; (*3*) slots; (*4*) closed-section channels; (*5*) jaws; (*6*) locking slot; (*7*) locking cord; (*8*) glass; (*9*) wooden wedge; (*10*) tubular frame; (*11*) self-tapping screw; (*12*) single-sided strip; (*13*) double-sided strip; (*14*) fixing strips

channels *4* are provided inside to make the gasket more flexible during installation. A slot *6* is made on the outside of the right-hand jaw to accept a locking rubber cord *7*. The shape and size of the slot are such that a certain force has to be exerted when fitting the locking cord into it. The walls of the slot can readily be forced apart when no locking cord is placed inside, but will not yield when the cord is in. The locking cord presses the gasket to the glass, thereby forming a hermetically sealed joint.

Two curved slots *3* having a depth of up to 7 mm are also provided at the bottom of the gasket, by which the gasket is fitted over the ridges *2* of the frame *1*.

As a starting point, cut the gasket into desired lengths. Take care to mitre the ends to make closely fitting connections. Put the lengths of gasket on the ridges, driving them home with a hammer. For better security of mounting, bond the gasket to the frame with a suitable adhesive applied to the ridges. In fixing the gasket, hold it with your left hand (if you are a right-hander), striking blows with the hammer in your right hand.

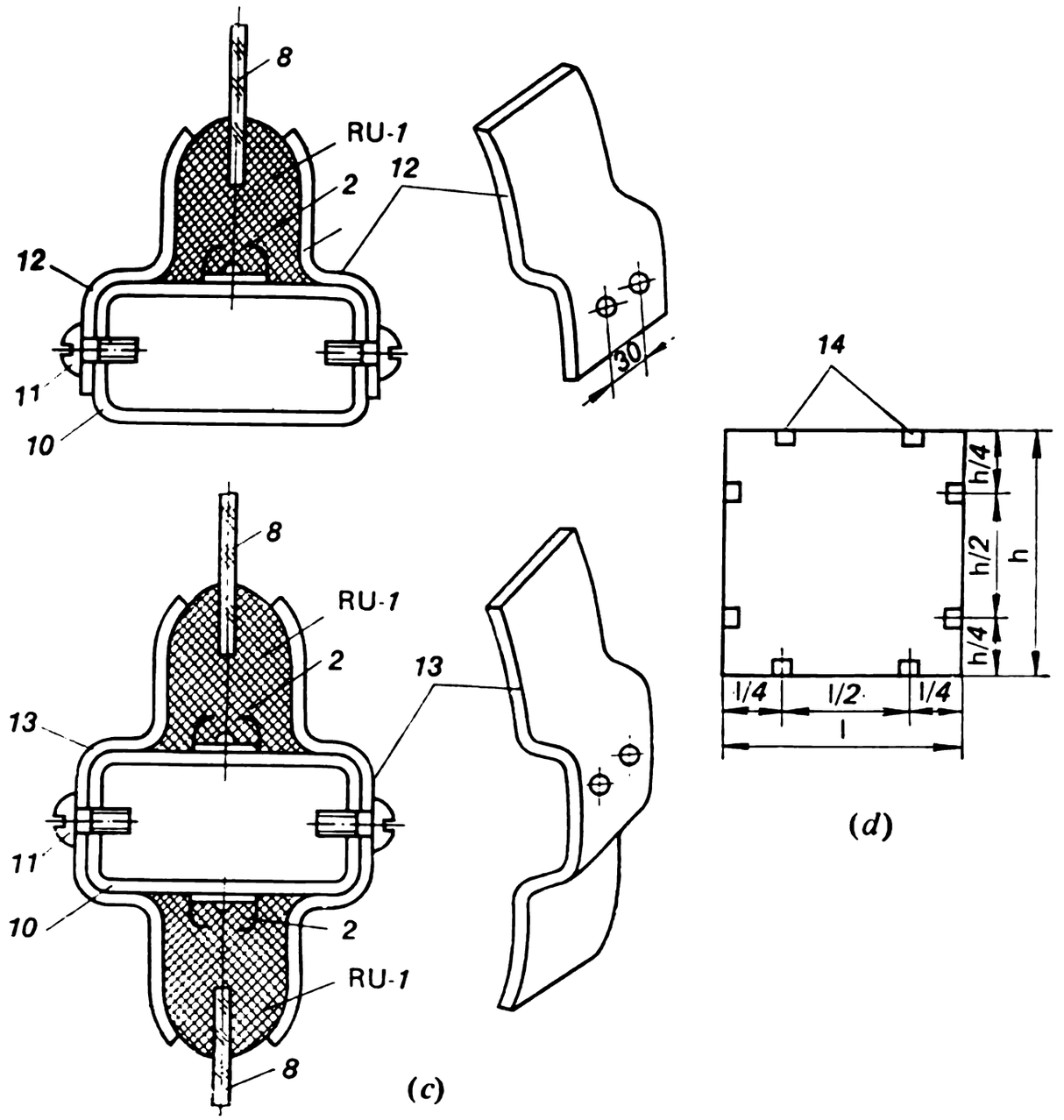


Fig. 78. (continued)

Measure the rabbet-to-rabbet distances and cut the desired plate of glass *8* with allowance for the thickness of the gasket. File off all the sharp edges with a honing stick. Since the glass thickness is 6 to 8 mm and the distance between the jaws at the top is 3 to 4 mm, the glass is practically impossible to insert into the groove without outside assistance. So, take care to place a length of rope, wire, or rubber cord *7* in the groove to spread the jaws apart before you set the glass. Then, lift the glass and place it in position. If the glass treads upon the jaws somewhere along the groove, spread the jaws apart with a wooden wedge *9* so that the glass

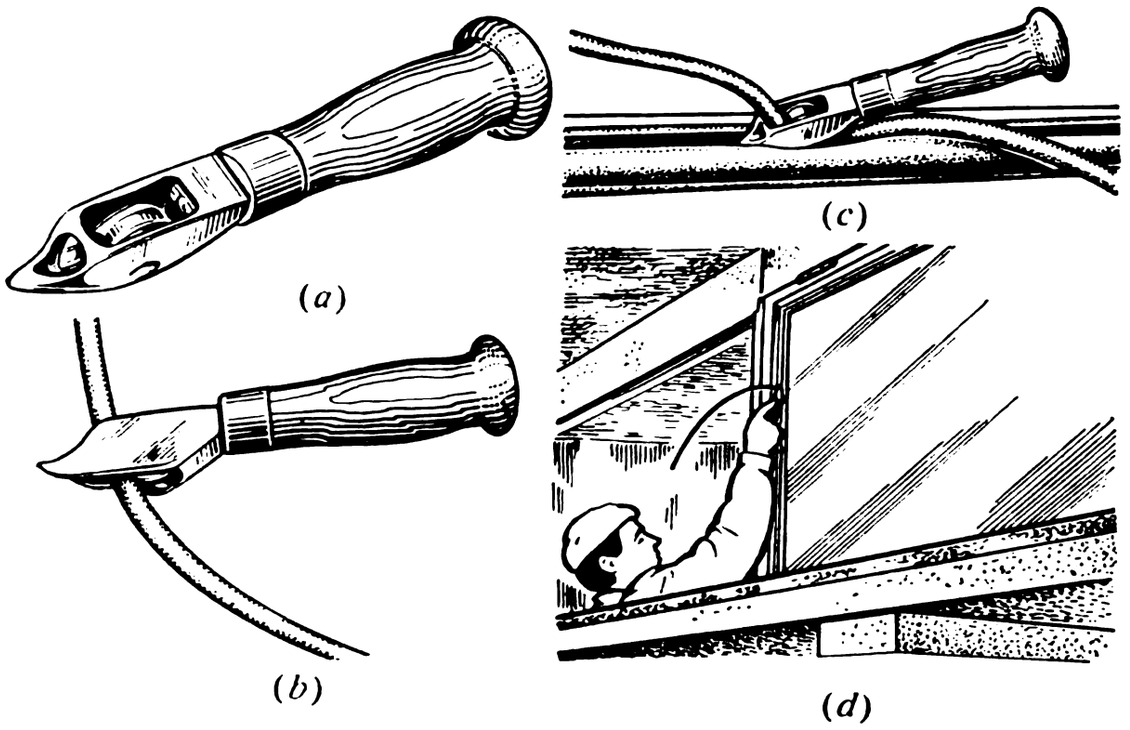


Fig. 79. Placing the locking rubber cord
(*a*) cord placer—general appearance; (*b*) cord placer—side view; (*c*) and (*d*) placing locking cord

may slide in and rest on the rope in the groove. Then, pull the rope out of the groove to place the glass deeply in the gasket. After the glass has been thus slipped into the bottom groove, begin fitting it into the side gaskets. For this purpose, use wooden wedges to force the jaws apart, working from bottom to top of the frame until the glass is held firmly in the gaskets around the periphery. Although the glass is at first slightly inclined with respect to the side gaskets, the jaws grip it firmly. They are rather difficult to spread apart and fix the glass as appropriate. So, it will be a good plan to drive wedges in the bottom portion of the side gaskets beforehand to facilitate the further placement of the glass along the sides.

After the glass has been fixed in the groove of the gasket, insert the locking rubber cord in the slot on the outside of the gasket. This is usually done with a rubber-cord placer (Fig. 79). The tool consists of a wooden handle and a pointed steel beak with a wheel. The wheel guides the rubber cord and forces it into the slot. Cut off a piece of rubber cord of desired length and insert it into the tool with the longer end up and the shorter end down. Force the beak into the slot

and move the tool with the beak forward, exerting some pressure on the handle. The beak will spread the sides of the slot apart, and the wheel will press the cord into the slot. As the placer moves farther along the frame, the slot sides return to their original position and hold the cord firmly in place. The first length of cord sometimes fails to be driven the full distance into the slot and needs additional pressing after the rest of the frame has been filled. The placer may be moved in any direction along the horizontal gaskets, while with the vertical gaskets it should be driven from bottom to top only. The meeting ends are cut at an angle and lap-spliced to make the connection more reliable. No sealing is needed.

Where no ridges are provided inside the frame, the type RU-1 gasket is fixed by means of steel strips 60 mm wide. Depending on the shape and size of the frame, use may be made of single- or double-sided fixing strips (see Fig. 78*c*).

Two holes are drilled 30 mm on centres in each strip. The strips are seated on a bed of type ALG-1 primer or putty. At least two strips should be installed along each side of the frame.

Wooden frames are glazed similarly to metal frames. The glass is secured in place by wooden glazing fillets fastened to the rabbet with wood screws. Before glazing, make sure that the bottom rabbet is adequately smooth. If necessary, give it some planing to bring it to a true surface.

Where they are placed on top of a U-shaped rubber gasket, press the fillets hard into the rubber as your teammate fixes them with wood screws. Cut off surplus rubber squeezed out of the joints and cover the connection with putty or paste oil paint around the periphery to make it leak-proof.

Rubber gaskets may sometimes be replaced by strips of felt or cloth impregnated with drying oil, bitumen mastic, or machine oil.

36. Removal of Plate Glass from Frames

When they become unfit for use, glazed metal or wooden frames should be replaced with sound articles. The glass may be reused, for which purpose it should be carefully removed from the frame.

Where the glass is to be taken out high above the ground, appropriate scaffolds should be erected. The scaffold platforms should come 4 or 5 cm short of the bottom edge of the glass. To begin with, take out the screws and carefully remove the glazing strips. Hold the glass to prevent it from falling out as you extract the upper strip. Pull rubber gaskets and scrape putty out of the rabbet. After that, remove the glass with suckers or by hand and place it on wooden pads, first one side then the other. If the glass refuses to come out, strike several blows on the frame with a hammer or drive a few wooden wedges between the glass and the frame from the inside and tap on them lightly with a hammer to force the glass out of the rabbet. Hold the glass to prevent it from falling down as you do so. When it has been installed on the pads, pass straps under the glass plate and lower it on the ground.

If the glass is broken, the first thing to do is to clear the rabbets. Remove the glass piece by piece, beginning with smaller fragments. Wear gloves to protect your hands against sharp edges.

Chapter Ten

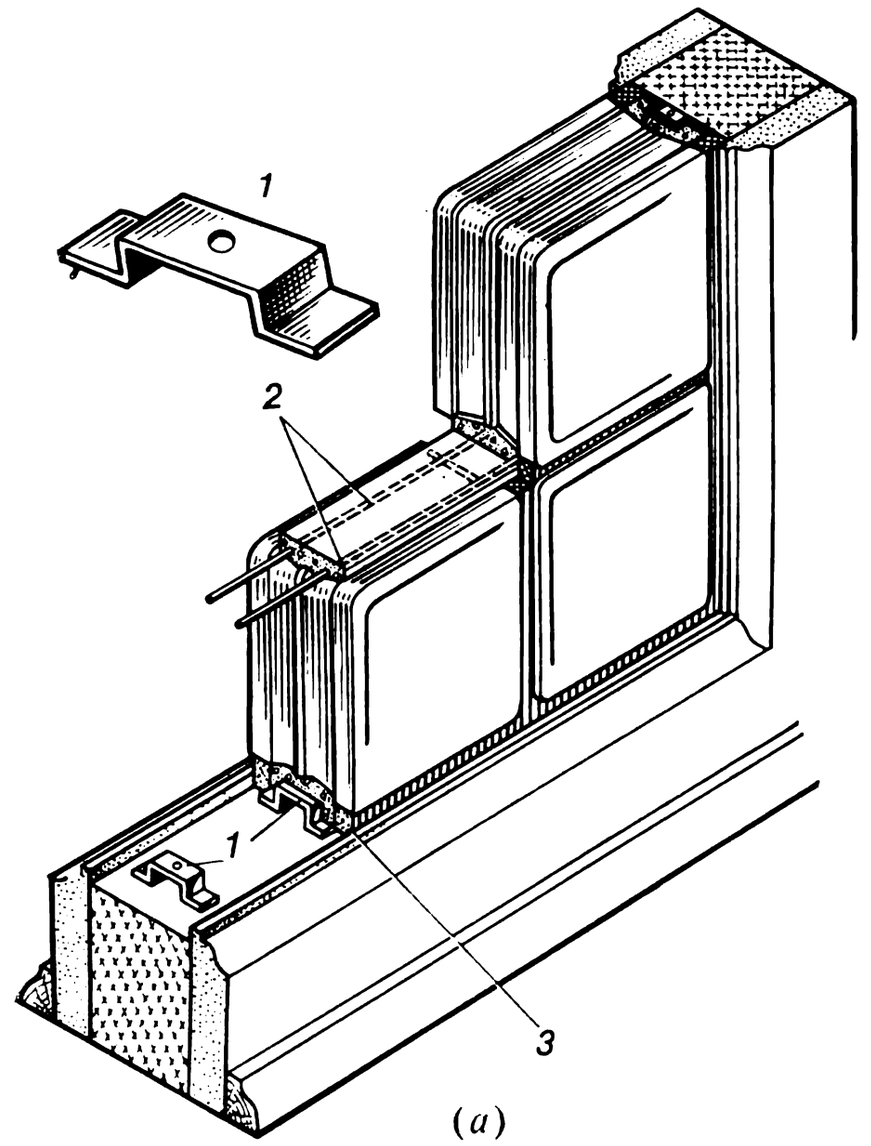
Placing Glass Blocks, Tiles, Structural Glass Shapes, and Multiple Glass Units

37. Placing Glass Blocks

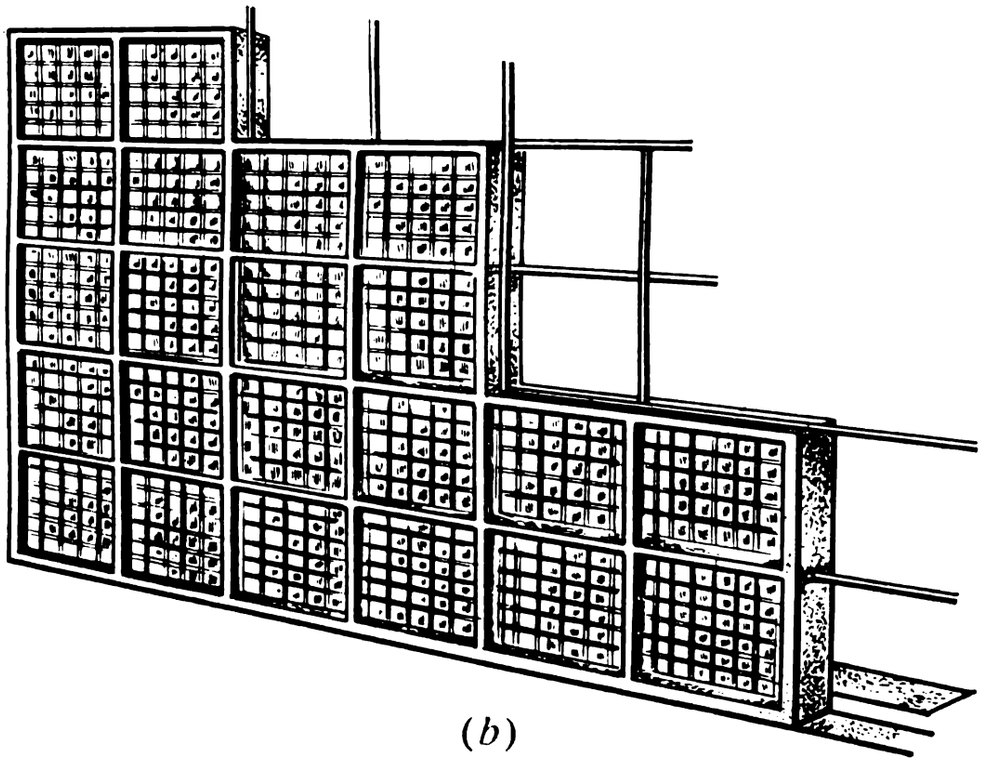
Glass blocks are used to glaze window openings in corridors, bathrooms, staircases, and other places where diffused lighting is desired. They are laid in cement mortar with no frames.

If necessary, the lower courses of glass-block masonry may be placed on resilient base pads.

As a starting point, fill the opening with glass blocks using no mortar to determine the thickness of the joints. Then, take the blocks out and begin laying the base course. For



(*a*)



(*b*)

Fig. 80. Placing glass blocks
(*a*) with metal clamps; (*b*) with reinforcing wire; (*1*) metal clamp; (*2*) reinforcing wires; (*3*) cement mortar

this purpose, spread a bed of mortar *3* (Fig. 80) across the width of the wall and place blocks making sure that they run horizontally. For better stability and stiffness, install metal clamps *1* on the wall under the base course as shown in the figure. Place one or two 5- to 10-cm-diameter reinforcing wires *2* in the horizontal joints, so that they run continuously the full length of the joint if possible. Apply mortar to the bottom and sides of each block. Take care to fill the chases completely. Strike off surplus mortar with

Fig. 81. Placing glass blocks—job layout

a trowel (Fig. 81) and wipe the blocks clean as you fill in the opening.

38. Glazing with Tiles

Glass tiles of various shape and size (lenses, prisms, and the like) are set in metal or reinforced concrete grid-like frames. The mortar formulation is 1 : 3. To begin with, lay a bed of mortar 3 to 5 mm thick on the flanges of the glazing bars. Then, press the tiles hard into the frames to squeeze out surplus mortar. Make sure that the tiles bear against the rabbet and are level with the top flanges of the

glazing bars. Fill the gaps with mortar and smooth out the joints. Wipe the tiles clean after the mortar has set.

Glass tiles are embedded in cast-in-situ reinforced concrete roofs in the course of concreting. Here, the reinforcement is placed in such a way that cells are provided for the tiles. The tiles are set with their edges lined up with one another both across and along the roof. They are fixed in position with small dabs of mortar so that they are not displaced when the roof is cast. Concrete may be poured in the forms only after the dabs have set. After the concrete has developed an adequate strength, the tiles are cleaned from mortar and wiped on the outside. The bottom surfaces are wiped clean when the formwork is dismantled.

39. Setting Structural Glass Shapes

The various techniques employed in setting structural glass shapes are illustrated by Fig. 82*a* and *b*. Clean the shapes *3* by hand or with a jet of compressed air. Cut rubber sealing strips 20 to 25 mm wide (to be installed in the joints between the members) or 100 to 120 mm wide (to be placed around the periphery of the frame or window opening). The sealing strips should be of the same length as the glass shapes.

In filler structures, glass shapes are fixed with metal angles or wooden fillets. The length of the angles or fillets should be 1 250 to 1 500 mm per five channels or ribbed members.

Remove the contour angles from the frame around the periphery and bond strips of cellular rubber with type 88N adhesive on the inside. Clean the side surfaces of the glass shapes from dirt and dust, degrease them with a suitable solvent, and bond strips of cellular rubber to the glass. Apply the adhesive in a continuous ribbon or in dabs at 40- to 50-cm intervals. Use type KN-2 mastic if sealing strips are made of PVC or similar plastics.

Put a cap of appropriate shape on the top of each glass member to protect the glass against damage and to make the joints leak-proof. Assemble the prepared members into panels (five members per panel), place one such panel in a cassette, and lift it to the job by a crane.

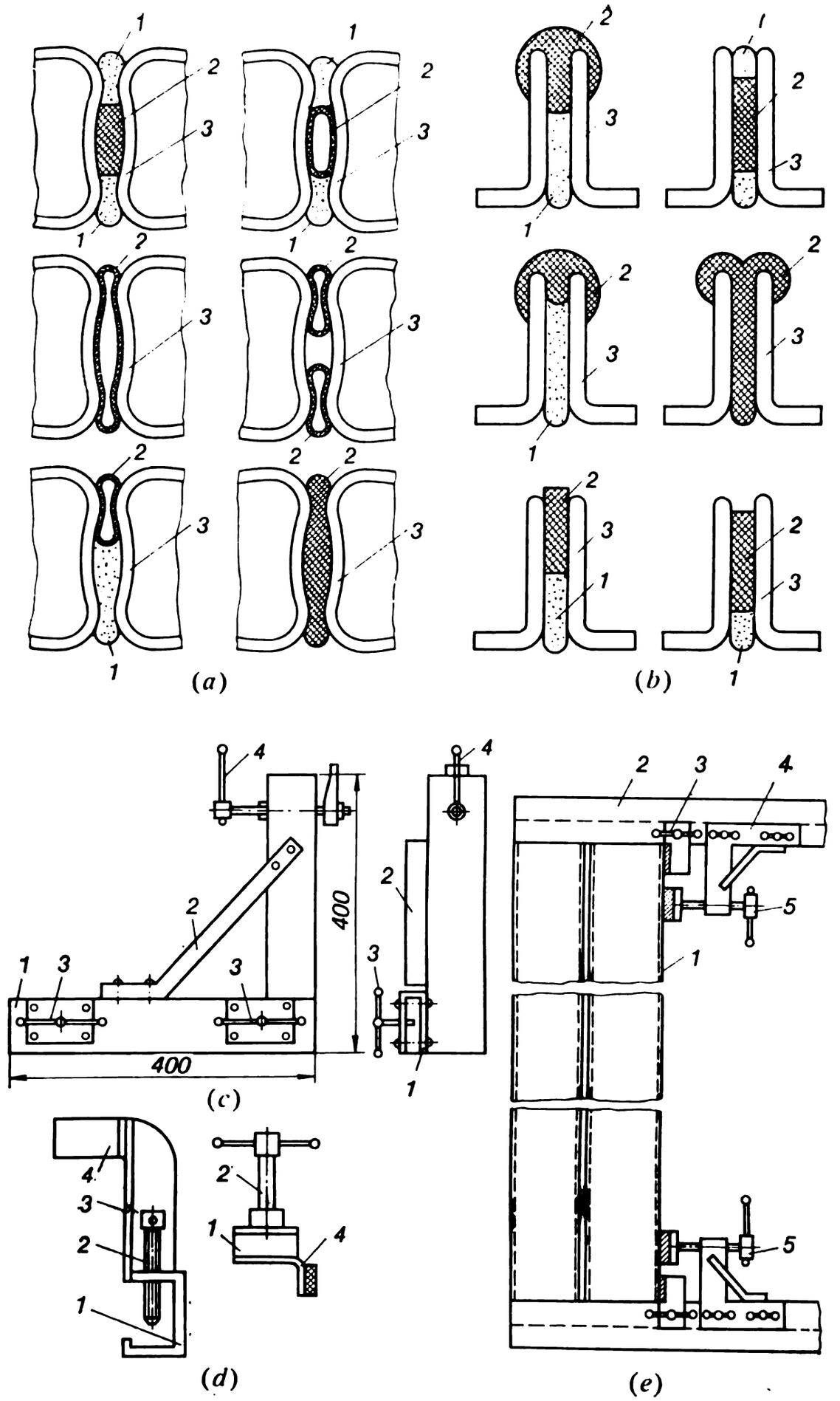
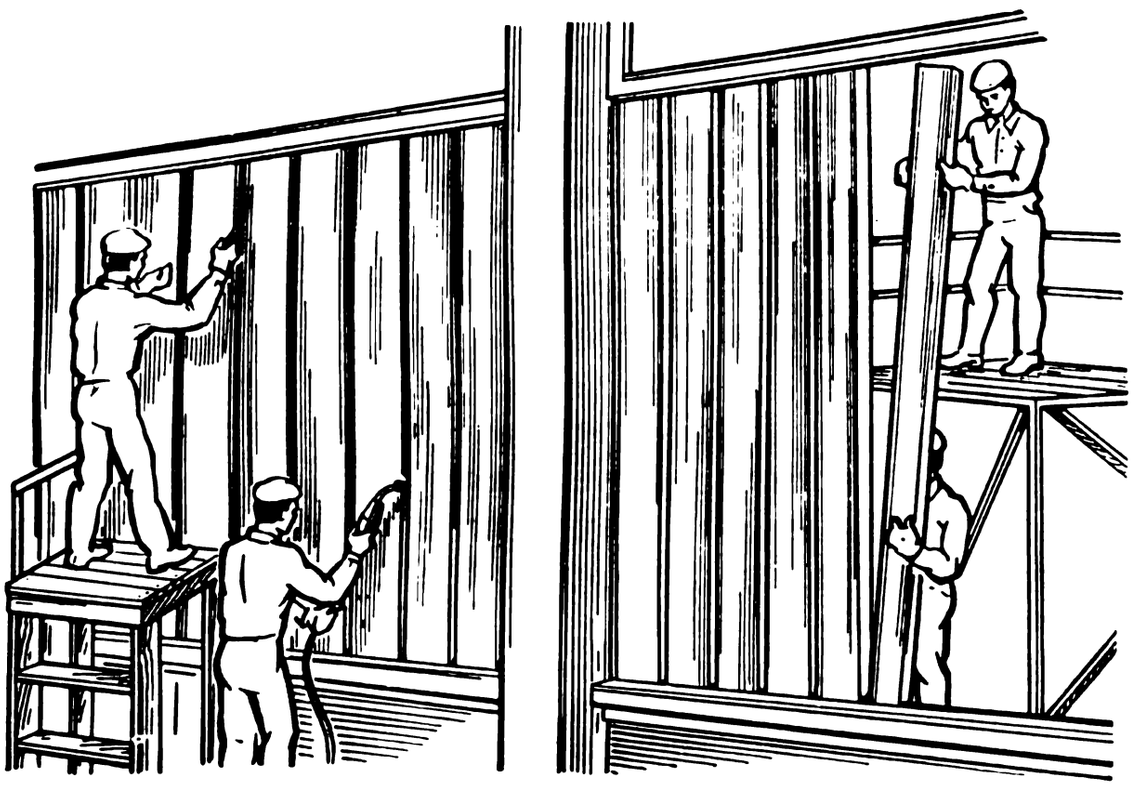


Fig. 82. Placing structural glass shapes
(*a*) placing sealing strips between box-shaped members; (*b*) placing sealing strips between channels; (*1*) mastic; (*2*) sealing strip; (*3*) glass member; (*c*) screw jack; (*1*) base plate; (*2*) bracket; (*3*) fastening screws; (*4*) piston; (*d*) cramp; (*1*) base plate; (*2*) fastening screw; (*3*) bracket; (*4*) rest strip; (*e*) placing glass members piece by piece; (*1*) glass; (*2*) frame; (*3*) cramp; (*4*) screw jack; (*5*) piston; (*f*) placing glass shapes and sealing joints



(*f*)

Fig. 82 (continued)

Where a crane is available, the gang consists of three workmen and a crane operator. Depending on how high the opening is above the ground, a scaffold with one or two working panels should be used. Here, one of the workmen stands on the upper platform and the other two, on the lower platform or on the ground.

Let us now discuss how structural glass shapes can be fitted into an opening piece by piece. As a point of departure, install the upper angles (be sure not to turn the screws tight). Fit the glass shapes into the opening (no more than five members at a time) and secure them in place temporarily with fastening angles. Install screw jacks (Fig. 82*c*) at the top and bottom of the frame and press the members together by the jacks until the sealing strips are squeezed to a 2- or 3-mm thickness (which is about one half their original thickness). Check the members for verticality and fix them in design position temporarily by cramps (Fig. 82*d*) installed at the top and bottom of the frame. Dismantle the screw jacks, drive the screws holding the glazing bars

as far as they will go, and remove the cramps. Then, proceed in the same way to install another five members, etc.

Be sure to slip wooden blocks 50 × 50 mm in cross section and at least 500 mm long between the member sides and the jack pistons to protect the glass against damage. Where the jacks cannot be installed (say, near walls, partitions, or columns), the glass shapes are left unclamped.

After the members have been set in design position, wash the joints clean, allow them to dry, and degrease them with a suitable solvent. Then, prepare a polysulphide (Thiokol) sealant (if the ambient temperature is not lower than 5°C) and apply it to the joints by a pressure gun, putty knife, or brush, taking care to smooth it out at once, because it sets very quickly.

Before the installation of the glass shapes, the metal frames should be cleaned from rust and painted.

Where several tiers are to be glazed, begin with the topmost tier. Panels are installed in the reverse order. The lower panels should be covered with boards to avoid breakage.

40. Setting Multiple Glass Units

These are prefabricated elements which need no trimming on the site and may be placed directly into position. For this purpose, wipe a unit clean on both sides, slip a U-shaped gasket over its edges, and mitre the gasket in the corners to make a tightly fitting connection. Join the meeting ends of the gasket with staples, and set the unit in the frame. Cut off surplus rubber and seal the joints with a polysulphide (Thiokol) compound.

41. Safety Precautions

Work from sturdily built scaffolds and wear safety belts when glazing openings high above the ground. NEVER work standing on makeshift supports or scaffolds lacking continuous platforms.

Leave the scaffolds when it rains or snows or when the wind is heavy (grade 6 upwards).

Make sure that your percussive tools are fitted over strong shafts free from burrs.

Take care to heat mastics in a water bath. NEVER use an open flame to avoid explosion.

Be sure that glass shapes are placed on wooden pads in all situations.

Store blocks, tiles, and the like in boxes.

NEVER smoke when handling mastics or sealants based on volatile solvents.

Wear safety goggles and gloves when breaking or chipping glass shapes.

Chapter Eleven

Repair. Placing Inner Sash. Glass Cleaning

42. Repair of Window Glass

General. To begin with, remove broken fragments of glass. Clean the rabbet from old putty and extract the sprigs. Allow the wet sash to dry, give the rabbet a coat of drying oil, and set a new pane of glass.

Larger fragments may be used to cut panes for ventilators.

If the broken glass is firmly held in place (as may be the case where it is bed- and face-puttied), remove the smaller fragments first and then make cuts and break off the stubborn portion.

Glazing Sash with Several Panes of Glass (Built-up Glass) (Fig. 83). Here, no more than two pieces of glass may be used at the same time. The panes are overlapped, the width of overlap being at least 20 mm. The first to be set is the lower pane. To prevent it from sliding down, the upper pane *4* is fixed in position with at least two clips *7* and covered with putty *6* on either side*.

Three or four clips may be required where the sash is

* The clips are strips of tin or roofing steel 10 to 15 mm wide.

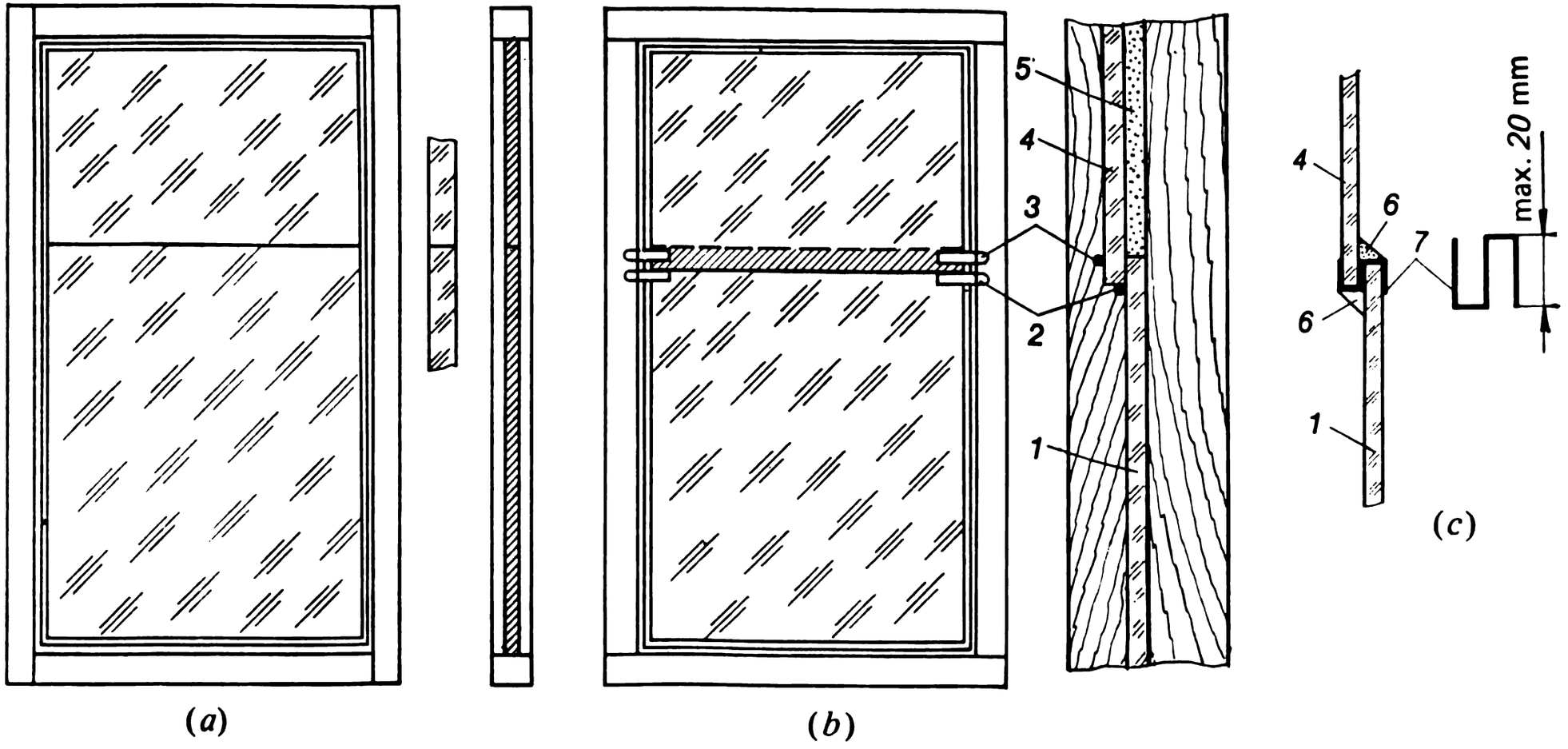


Fig. 83. Placing built-up glass
(*a*) butt-jointed panes; (*b*) lap-jointed panes; (*c*) joint details; (*1*) lower pane; (*2*) glazier's points; (*3*) glazier's points; (*4*) upper pane; (*5*) bed putty; (*6*) putty over joint; (*7*) clip

wide. The clips are folded in such a way that they do not stick out of the overlapped portion.

Sometimes, the clips may be replaced with glazier's points *2* and *3* driven into the rabbet at a distance of 20 mm from each other. The principle of operation of the glazier's points can be understood from reference to Fig. 83*b*.

This practice should be avoided when fixing broken glass in residential buildings and may only be used in temporary dwellings. The pieces of glass may be overlapped either vertically or horizontally, the horizontal arrangement being preferable. Although relevant standards do not approve of this method, glass may sometimes be butt-jointed. Joints like that have a more pleasing appearance and pass little air if the glass is cut right to size. Glass of the same thickness should be used for the purpose, with the edges lying level with each other, to prevent injuries when washing the windows. To make the joint air-tight, place some putty on one edge and squeeze the panes together. Strike off surplus putty and wipe the joint clean. You may use zinc or lead white of paste-like consistency instead of putty if the joint is to be masked as much as possible.

Overlapping produces a clearly visible joint which, however, passes very little air. For better tightness, place some putty on the rabbet before setting the second (upper) pane. Press the glass hard into the putty, so that its edge is snug against that of the first (lower) pane *1*.

With built-up glass, sprigs or nails must be driven at shorter intervals than with whole panes and on either side under the edge of the upper glass.

After the glass has been fixed in position with sprigs and face-puttied (or secured with glazing beads), place some putty on the joint and smooth it out to form a fillet.

A cut-out should be made on the bottom surface of the glazing beads to give better support to the upper pane. As an alternative, strips of wood may be placed under the edge of the pane level with the glass surface, in which case no cut-outs are required.

Placing Fresh Putty. Remove old putty and drive several sprigs into the rabbet. Allow the wet sash to dry and give it a coat of drying oil or paint. After the drying oil or paint has dried, place fresh bed putty on the rabbet.

The outer sash are exposed to weather and are, therefore, wetted from time to time. This not only impairs the putty but also causes substantial damage to the rabbets. As part of routine maintenance, take the glass out, remove old putty from the rabbet, allow the rabbet to dry, give the rabbet a coat of drying oil or paint, and place fresh bed putty. Then, press the glass into the rabbet and face-putty it throughout. Strike off surplus bed putty squeezed out of the joint and trim the edges. After the putty has dried, paint the sash on the inside to extend the life of the putty.

Repair of Glass Secured with Glazing Beads. Extract the nails if the glazing beads are nailed to the rabbet. For this purpose, insert the blade of a wood chisel between the glazing bead and the rabbet and lift the bead slightly. As you pull out the chisel, the bead usually regains its original position, leaving the nail heads sticking out. Pull out the nails with tongs and remove the glazing beads.

If the glazing beads are fixed with wood screws given several coats of paint, begin with cleaning the slots in the screw heads, using an awl or any other suitable tool. Then, remove the screws with a screwdriver, either completely or leaving them in the bead. Take the beads out with care so as not to break the glass, because it often happens that the sash needs fresh putty only.

If the glass is intact but the beads are rotten, use new glazing beads. Cut them to size, mitre the ends, and give them one or two coats of drying oil and paint. Scrape old putty off the pane, place some fresh putty on the beads, and nail or screw the beads to the rabbet.

If the glass is broken, proceed as prescribed previously.

The bottom glazing bead should always be bedded in putty, even though the other beads may be set dry. The thing is that water keeps flowing under the bead and may speed up decay.

43. Repair of Plate Glass

Fragments of broken plate are fixed by two metal or wooden shims of various diameter placed on either side of the glass and held together by a small-diameter bolt passed through a hole which is either drilled or chipped out.

Holes are made with a hand drill, a power drill, or a brace. Ordinary bits for drilling holes in metal or wood are unsuitable for glass. Here, use should be made of hard-steel drills manufactured of a piece of file with a pointed tip having three or four sides that would chip out tiny particles of glass.

To begin with, place a back-up strip of wood on the other side of the plate and press it tightly to the glass. This is done to align the glass fragments in the same plane, because new crack may develop in the course of drilling otherwise. Set the drill at the desired point, press it lightly to the glass, and begin drilling, dipping the bit in turpentine from time to time to facilitate drilling and to prevent small chips of glass from flying away. Drilling is said to be taking its normal course if white dust comes out of the hole. Glass crumbs appearing on the surface instead of the white powder will indicate that the drill either needs sharpening or has to be replaced altogether.

Drill the hole half-through, then complete the hole working from the other side. Sometimes, drilling is done in two steps: at first, a leader hole of smaller diameter is made, and then it is enlarged with a drill of desired diameter. Rotate the drill slowly, dipping it from time to time in turpentine or a rosin-turpentine compound (4 to 7 parts of turpentine stirred in 1 part of melted rosin).

After the hole has been drilled, put a shim *4* made of a non-corrodible material (Fig. 84) on a bolt, pass the bolt through the hole, slip the other shim on the end, and tighten a nut *2* which should be placed inside. With wooden shims, slip a washer *3* and a wooden shim *4* on a bolt, insert the bolt into the hole, place the other shim and washer, and tighten the nut *2*.

The nut should not be screwed down too tight to avoid breaking the glass. Sometimes, rubber spacers are placed under the shims to take up excessive pressure.

As already mentioned, holes may be chipped out with a small hard-steel hammer having a pointed peen *3* at one or both ends of the head (Fig. 85). To chip out a hole, ask your teammate to press the face of a hammer *1* on the other side of the glass *2* right against the point where the hole is to be punched. Take the hammer and strike light blows to

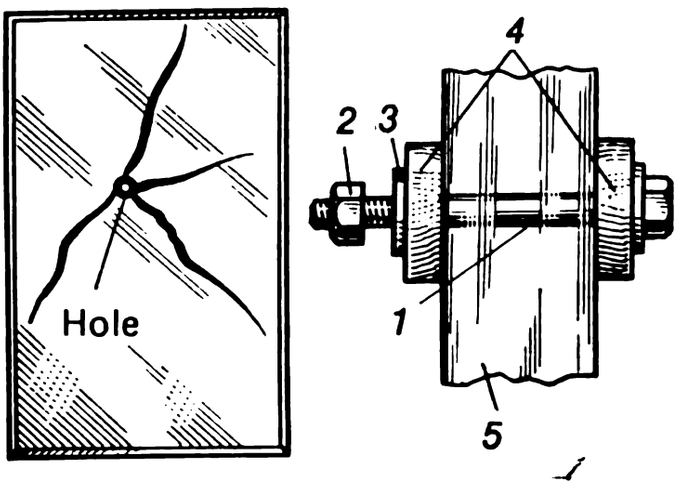


Fig. 84. Fixing plate glass
(*a*) bolt; (*2*) nut; (*3*) washer; (*4*) shim; (*5*) glass

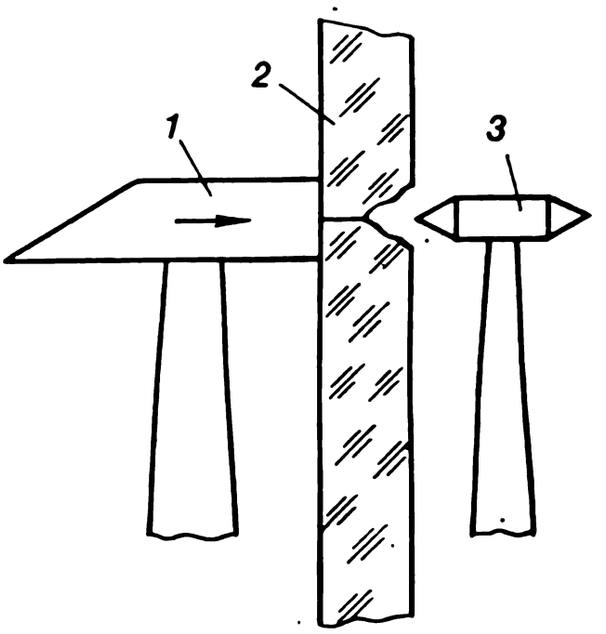


Fig. 85. Chipping out a hole in plate glass
(*1*) back-up hammer; (*2*) glass; (*3*) pointed-peen hammer

chip out small fragments of glass until you punch the hole through. As an alternative, you may chip out the hole half-through and complete it from the other side.

Be sure to wear safety goggles when drilling or chipping out holes.

44. Repair of Glass Blocks, Lenses, Prisms, and Structural Glass Shapes

Broken blocks, *lenses*, and *prisms* are chipped out with a chisel. The mortar is removed by chiselling, too. Dirt and dust are brushed away and the opening is washed clean.

If it turns out to be larger than the hole to be filled, the new unit may be filed to size or the rabbets in wooden or reinforced concrete frames may be enlarged (the latter approach is inapplicable to metal frames).

Place the glass into the hole and fill the gaps with cement mortar, bringing it to a true surface.

Where spare blocks or tiles are not available they may be replaced with flat (preferably plate) glass cut to size and installed in several layers. However, the constituent layers frequently break if they are unbonded to one another. Therefore, it is common practice to bond them with nitrocellulose lacquer or epoxy resin.

Whatever its type, place the glass level with the frame surface. If necessary, use strips of wood or aluminium or lay a bed of cement mortar to back up the glass. Avoid sinking the glass below the surface, because water will collect in this "well" and leak through.

Being very strong mechanically, lenses and prisms may not be replaced with glass blocks which are not designed to support any load other than their own weight. If no adequate glass substitutes are available, fill the holes with grout or plug them with wood.

When filling the holes with grout, clear the hole, fix a form (a piece of board or plywood) from beneath, and cut several lengths of reinforcing wire. Prepare the grout (one part of cement to three parts of sand), pour it into the hole to form a layer 1 to 2 cm thick, place the reinforcing wire, and fill the hole full, striking off surplus grout level with the top of the frame. Allow the grout to develop strength for 5 or 7 days and remove the form.

A wooden plug is installed level with the frame, given a coat of drying oil and two or three coats of paint, and poured over with melted bitumen.

Structural glass shapes are repaired by replacing broken or cracked members with healthy ones. To begin with, remove the contour angles or fillets from the top and bottom. If the member to be replaced has broken into small pieces, remove the fragments and clear away the debris. If it has merely cracked, take it out as a single unit. If the member has broken into two or three large fragments, remove them beginning at the top. Ask your teammate to hold the lower

pieces as you handle the upper ones. After the broken members have been removed, clear away the debris, and install the new glass shapes in the usual fashion. Upon completion of the installation, return the angles or fillets to their proper position and force sealing strips in between the members, using thin wooden wedges. After that, fill the joints with a suitable sealant. Keep the glass dry during both the installation and sealing.

Sometimes, an alternative approach may be employed by which the whole glass shapes are taken out of the frame as far as the broken element, the broken member is replaced with a new one, and the other shapes are fitted back together with their sealing strips in the regular manner.

Cutting (if any) should be carried out on an appropriate machine. If no machine is available, make two cuts with a *wheel-type cutter and break off the glass piece by piece with pliers or a small hammer. Then, file off the sharp edges with* a honing stick.

45. Placing Inner Sash

Windows account for two-thirds of heat losses in buildings. In cold weather, the heating bill may be cut down by placing inner sash. However, the inner sash, very much like their outer counterparts, should be properly prepared for the cold season to serve their warmth-keeping function well. If the sash are poorly prepared, the glass will mist up, and the moisture will either freeze or run down the glass, finding its way into the wood and promoting decay. In wooden buildings, water running down the walls may affect the structures below. It may also get into the basement where it will raise humidity, which is often accompanied with mould and house fungi. Once infested with fungi, the building will take a good deal of time and money to cure.

Before setting inner sash in the frames, wash and wipe the glass clean, allow it to dry, and remove old putty. Then, clean the rabbets, allow them to dry, and place fresh bed putty.

Set the sash (especially if they have no ventilators) in warm, dry weather to be sure that the air in the space between

the inner and outer sash is dry. The weather is not much of a factor where ventilators are present.

To place the inner sash, proceed as follows. Lock the outer sash and fill the gaps between the meeting stiles and also between the sash and the frame with a glazing compound. Place cotton wool, dry sawdust, dry sand, or any other suitable material in the space between the sash and cover it with paper. These materials intercept the air coming in through the gaps and prevent condensation. Next, set the inner sash in the frame and lock it as appropriate (this need not be done if the sash is of the fixed type). Fix the sash in the frame with nails for better security and fill the gaps and holes with a glazing compound. It is also advisable to paste strips of paper over the gaps between the meeting stiles and between the sash and the frame.

To improve moisture absorption and, hence, to prevent condensation, put vessels filled with hygroscopic substances between the sash. The best results are yielded by sulphuric acid containing not more than 4 to 7% water.

Pour sulphuric acid into glass vessels. Fill the vessels one-third or half full, because the acid grows in volume as it absorbs moisture from the air and may flow over the brim. This is extremely undesirable, since the acid might destroy the paint on the sash and frame and get into the wood, producing an unpleasant odour.

Dry table salt or calcium chloride are sometimes used instead of sulphuric acid. These are likewise placed in glass vessels in the same quantities as the acid. However, they are less convenient, because they quickly become saturated with moisture and cease to absorb it as soon as a state of saturation is attained.

It is hardly advisable to prevent the glass from misting up or icing by rubbing it with salt or pouring it over with salty water. The thing is that salt makes the wood permanently wet and causes the paint to peel off the sash and frames.

The glazing compound used for filling the gaps between the sash and frames should preferably be of the non-setting type (see Sect. 7 in Chap. III).

46. Glass Cleaning

The cleaner the glass, the more ultraviolet rays it transmits, which kill pathogenic bacteria and sanitate the air in the room.

Scrape off dry paint with a knife, putty knife, wood chisel, or any other suitable tool.

Various glass-cleaning liquids are on the market today. In using them, follow the manufacturer's instructions.

Stand on a chair, table, or ladder when cleaning glass high above the floor. When working from the floor, use brushes or similar tools wrapped in wet rags and fitted on long handles. If no such tools are at hand, nail a short strip of wood across a wooden handle at one end and wrap it in a wet rag.

At the site, the glass is cleaned and washed by appropriate machines. Various makes are available, some of them capable of cleaning up to 40 m^2 of glass per hour. Sometimes, the glass is also cleaned by hand with long poles reaching within 4 m of the floor.

47. Safety Precautions

Take broken glass away right after it has been removed from the sash. Wear gloves and safety goggles when breaking and removing fragments and drilling or chipping out holes.

Wear rubber gloves to protect your hands when dealing with acids and alkalis.

NEVER lean ladders upon the glass when cleaning the windows.

Use sturdily built scaffolds to set the glass high above the ground and take care to fence in the work place.

Wear gloves when carrying the glass from place to place.

After the broken glass has been removed, clean the bottom of the opening from debris and glass dust which may get into your eyes and cause nasty injuries.

Remove the fence and knock down the scaffold when the job is completed.

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